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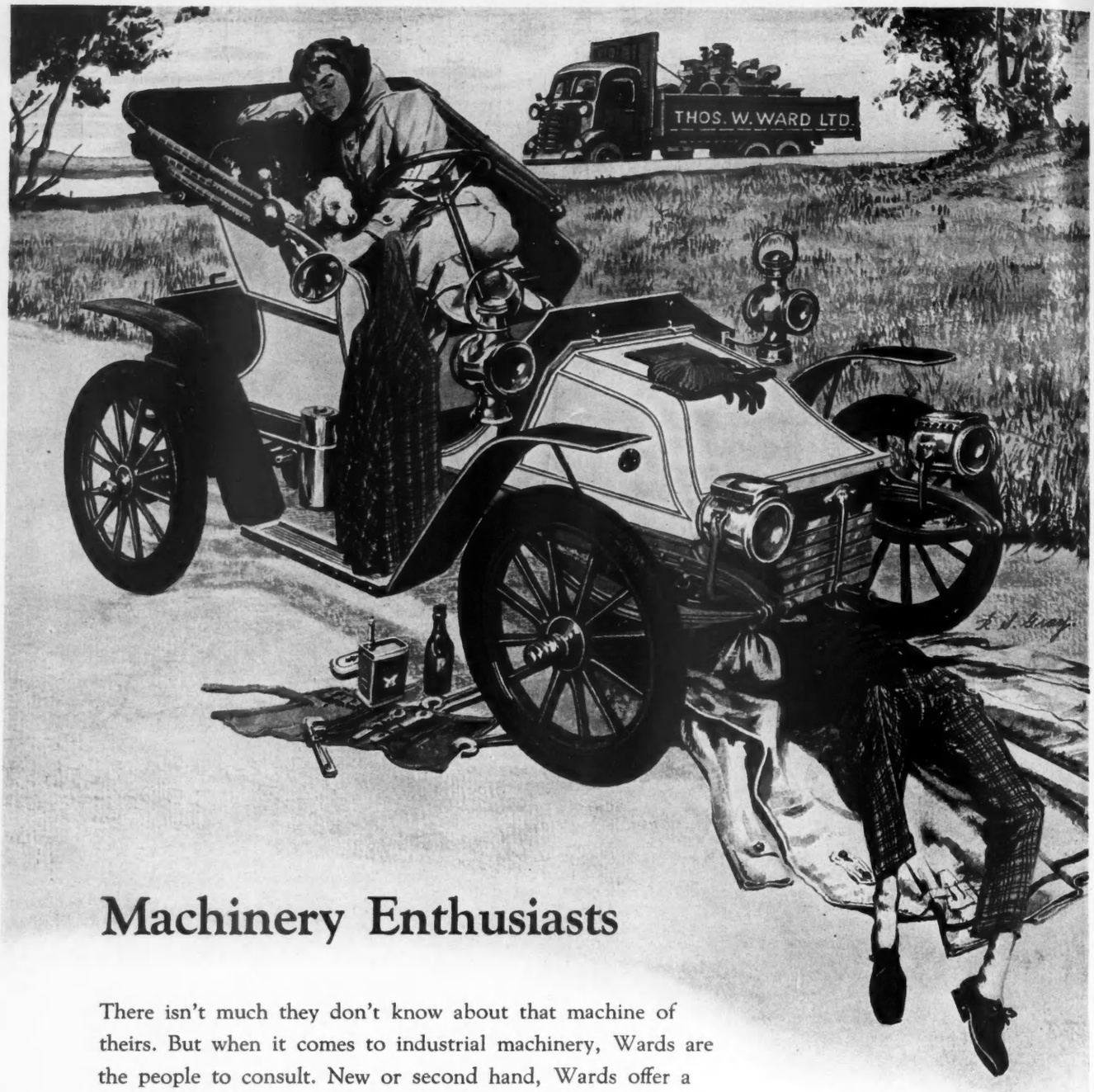

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Cover Picture

This week's cover picture shows the water circulating pump being fitted on to a six cylinder diesel engine. (*Nurnberg photograph for* ENGINEERING)

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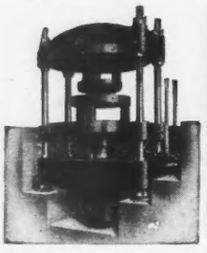

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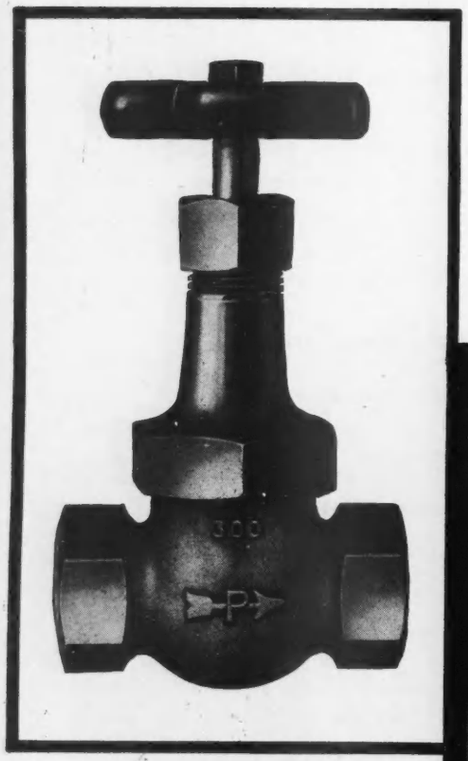

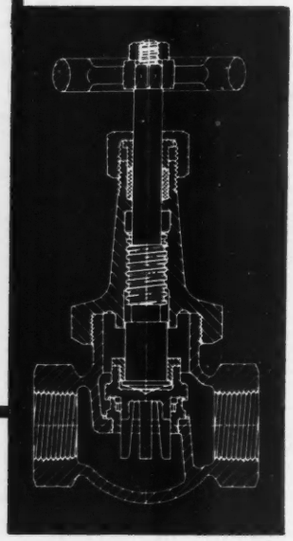

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ENGINEERING Impact

Aircraft Plans Stalled by Government

ANY jubilation over the British aircraft industry's successful penetration behind the Bamboo Curtain by selling Viscount airliners was immediately tempered by concern within the industry over the Government's lack of support for new aircraft, their inability to make quick decisions on important projects and their hesitancy over future policy.

Encouraged by the Government, nearly two years ago, to amalgamate, firms within the industry quickly responded, believing that by so doing they would receive considerable backing for new ventures. Since then no long-term Government policy has appeared and no major Government-sponsored projects have been initiated.

Under their own steam the British Aircraft Corporation have gone ahead with the VC10 and the One-Eleven, although a subsidy has since been provided which may help the Corporation to break even. Hawker Siddeley initiated the Trident, the Argosy and the VTOL P1127, though it is true the second of these has been ordered in quantity by the RAF, while a small development contract is in hand for the P1127.

The British aircraft industry is not so pessimistic about its future as some commentators would make out, but is aware of the need to change its shape even more than it has over the past decade. Aircraft cost ten times what they did fifteen years ago, less floor space is needed for production, more quality machining and less sheet-metal work is required. The result of all this will be a much more compact and sophisticated industry.

To formulate its future shape, closer Government-industry partnership will be needed, not only in the ever changing policy of defence but from the point of view of research and development of civil aircraft and aero-engines.

Shoes Built To Last

BRITAIN has another telling technical lead to set against harsher trading conditions abroad with the pioneer work of the British Boot, Shoe and Allied Trades Research Association. SATRA, as it is known, began with the support of the Department of Scientific and Industrial Research over 40 years ago, and today is acknowledged as the outstanding laboratory among those serving the national boot and shoe industries of the world.

Visiting the SATRA laboratories at Kettering, Northamptonshire, on 11 December, Mr. Denzil Freeth, Parliamentary Secretary to the Minister for Science, enlarged upon his appreciation of the value of such centralized research in market conditions today. We were in a superior world position, as exemplified by this industry, in realizing the ideal of the scientific approach co-ordinated with the diversity of commercial requirements.

Foreign challenge comes in the shape of substantial shoe imports—without doubt this is often to be ascribed to the influence of Continental fashion sources. In the long run, though, it is comfort and durability which matter—and in this organization there exists the potential both to fit these factors optimally into fashion trends and to develop production machinery for higher and more economical output.

The pursuit of engineering and ergonomic methods goes hand in hand here with intensive materials testing programmes aimed at solving problems of wear along mechanical and chemical lines. A preoccupation of the research at Kettering is in relation to the health of the feet—particularly of the young; and the SATRA "approved lasts scheme" for children is a signal example of applied research.

It is very probable that approaches from such sound first principles as these, in giving not only a product of better technical integrity but one constantly backed by an unrivalled technology, will weigh significantly in the country's industrial command.

Getting Commuters on to Rail

URBAN road and rail facilities are inadequate for the movement, at reasonable speed and in comfort, of the commuter traffic at the height of the peak period. This is true of many, if not all, the great cities of the world. Redevelopment of the central areas of cities—particularly the rise of tall buildings, with their concentrations of car-owning occupants and callers—is causing the commuter traffic problem to worsen. Can industrial and commercial interests continue to advance under such conditions, or must society become stagnant? Commuter traffic is the problem to be solved.

So far as London is concerned, the magnitude of the problem is best shown by a few statistics. Since 1933, road facilities in the centre of the area have not markedly changed, but the number of private cars registered in the area has increased by over 300 per cent, to more than 1,000,000 in 1960, and commercial vehicles by 200 per cent to 250,000; bearing in mind the insurance advantages of domiciling vehicles outside the central areas, it is certain that these figures do not exaggerate the growth factor. Currently, about 1¼ million people travel into and out of the area each weekday. In 12 hours, 120,000 vehicles pass by Hyde Park Corner.

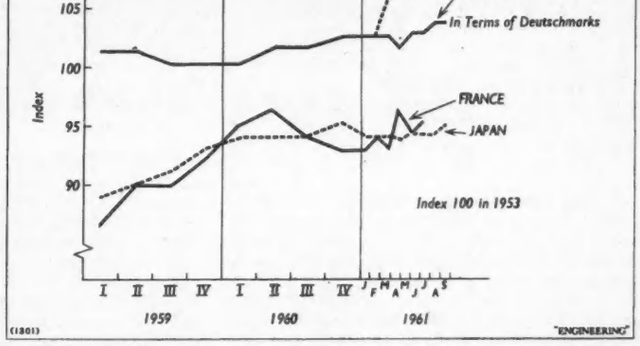
Mr. Anthony Bull, a member of London Transport Executive, considered some of the issues involved in obtaining a solution to the commuter traffic problem when he gave the 48th Thomas Hawksley lecture at the Institution of Mechanical Engineers (13 December). The objective of the authorities, Mr. Bull implied, was to make the overall journey from home to the office using rail services as quick and comfortable as the overall journey might be by private car. The same evening as Mr. Bull was giving his lecture, London Transport announced that they were starting work to clear up one of their blackspots—Euston Station, used by eleven million travellers every year. The scheme is designed in two parts; the second being to accommodate the Victoria Line, should that be built. Surely this would offer more relief to London's commuters than any other single project yet envisaged?

On car parking, Mr. Bull understandably favoured facilities at the outer stations, the traveller then transferring to the railway. Strong support for this approach also comes from New York. There, buildings in the central area are no longer provided with car parks because there is no room on the streets for the additional traffic which they would generate.

Export Prices Favourable

TRADE figures show that Britain's share in world exports was still falling during the third quarter of 1961, as reported in the November issue of the *National Institute Economic Review*.

But the picture of competition is ambiguous, for international movements of export prices have been in Britain's favour since the beginning of 1959 and her exports are steadily becoming more competitive as her prices have held steady since the early part of 1961, although those of the United States and of France have risen. Since the dollar price of German goods has risen even more steeply as a result of revaluation, the position now is even more favourable, if advantage can be taken of it.



Since 1959 Britain has kept her export prices fairly steady.

The fall in the share of world exports does not mean that total British exports are decreasing; on the contrary they are increasing, but the rate is not as great as those of her competitors. Although there is little real change, the balance of payments position looks slightly less favourable than at the last review two months ago. Stocks of imported goods held in this country have been reduced and it is probable that they will have to be replenished in the near future, swinging the balance to the wrong side. It seems more probable that at the beginning of next year it will stay about where it is, approximately balanced on the current account but an overall deficit.

At home, industrial production fell 2 per cent during September and consumption dipped following the Chancellor's measures. Some time in 1962, following the next round of wage increases, consumer expenditure will probably recover, and there will also be some stock building, both causing output to rise again. But the expansion will be modest.

Unemployment and vacancy figures show that demand for labour has been falling since May or June. This reduction in pressure in the labour market, as well as the Government's "pause" policy, are likely to delay wage settlements. How this will affect the output per head is by no means clear; during the third quarter, in manufacturing it was 1 per cent higher than a year ago, and in industry as a whole it was 2 per cent higher, mainly due to relatively rapid rises in mining and construction. The challenge now is to keep up this improvement and to take advantage of the still favourable export price position.

Doing the Washing for a Dozen Hospitals

AMONG the most essential of a hospital's services is the laundry, and it is significant that what has been described as a major advance in the laundry industry itself should have been inaugurated in a hospital laundry. For in hospitals, engineering is increasingly helping the doctors and nurses in their work of healing.

ENGINEERING has visited the hospital—St. John's at Lincoln—where they have installed two Cherry Tree-Braun automatic units which can increase threefold the average productivity per laundry man-hour, with big savings in water and steam, and with no intermediate handling of the washing at all. The operator works in entirely dry conditions.

Commercial laundries share with hospitals the difficulty of finding sufficient labour, probably because the traditional view of a laundry is one of damp floors and a steamy atmosphere. St. John's hospital establishes entirely fresh standards in laundry wash-room procedure and sets an example to others.

Where public money has to be spent it is not always easy to be the guinea pig for engineering developments. The management committee of St. John's are to be praised for their foresight in installing these units. Serving a dozen hospitals, this laundry is now able to do more work with the same staff, without enlarging accommodation and with a substantial saving in operating costs.

Free Piston Uses Outward Compression

Quick response to load changes, high thermal efficiency, and mechanical simplicity are features of a new free piston engine developed in Canada. The improvements result from the use of the outward compression cycle combined with an open engine frame.

SINCE the late 1930's considerable design, research and development has been conducted in the field of free piston gasifiers. The advantages peculiar to these engines have resulted in their increasing application in marine, rail and stationary power plants.

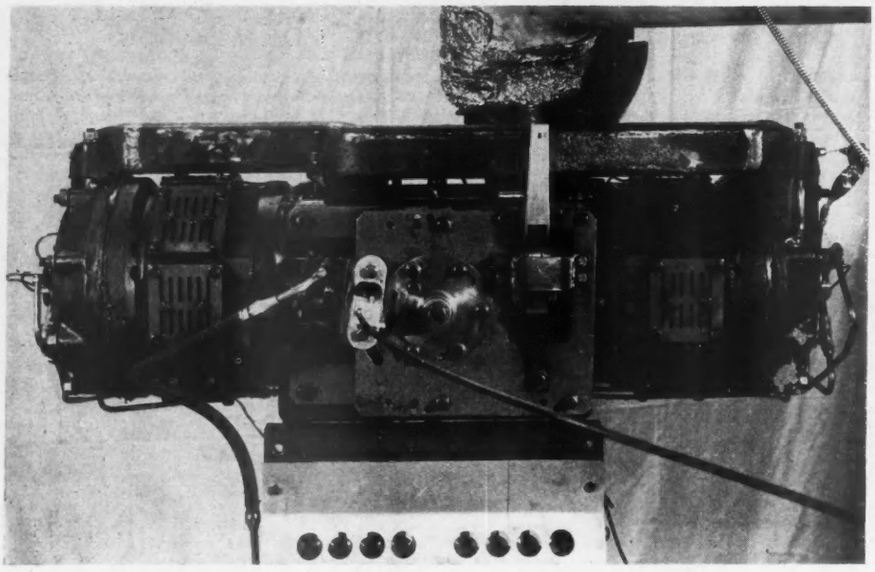


Fig. 1 Prototype Braun gasifier using outward compression.

During the course of its history two types of gasifier have been developed which are distinguished by the portion of the operating cycle that is used as the compressor stroke. Easier control and greater thermal efficiency are recognized advantages of the *outward-compression* type gasifier, but the mechanical complications which appeared to be inherent in the cycle have led most designers to develop the less efficient but simpler *inward-compression* engine.

The family of outward-compression gasifiers developed by A. Braun of Queen's University, Kingston, Ontario, Canada, achieves the recognized advantages of outward compression with the mechanical simplicity shown in Fig. 1. The Braun engine operates on the cycle shown in Figs. 2 to 6.

After combustion, Fig. 4, the stepped pistons are forced outward, Fig. 5, uncovering the exhaust ports to allow the exhaust gas to blow down and enter the turbine. As the pistons move outward, the air ahead of the compressor pistons is compressed, Fig. 6, forcing open the compressor discharge valves. The air then flows through the delivery duct and through the uncovered inlet ports of the diesel cylinder.

Approximately half of the air scavenges and cools the cylinder—mixing with and cooling the exhaust gas—and then flows to the turbine. The remaining half is trapped in the diesel cylinder for the next combustion when the converging pistons cover the inlet and exhaust ports.

Compressed air in the bounce and compressor cylinders provides the return work necessary for the inward piston stroke. During the stroke, the compressor pistons create a slight vacuum, drawing the fresh air charge in through the compressor inlet valves. The pistons move to the inner dead point, Fig. 4, where fuel is injected and combustion occurs to complete the cycle.

Following the encouraging performance of a hand-made 40 gas hp engine in 1957, the Free Piston Development Company Limited, Queen's University, was formed as a consulting and licensing firm, with Professor J. S. Campbell, president; A. Braun, technical director; and two other directors: E. Siemonsen and Professor W. G. Colborne. The engine attracted the interest of the Ingersoll Machine and Tool company Limited, Ingersoll, Ontario, in 1958, who manufactured three 70 gas-hp models under licence. At the present time five 80 gas-hp engines are being manufactured by the Ingersoll Company for marine and stationary use.

In the following discussion of the features and advantages of the Braun design, all specific information applies to the 80 gas-hp model BR-3500-8. In addition to the established advantages of free piston engines in general—such as inherent balance, quick response, compactness and multi-fuel operation—the Braun design has also a number of unique advantages.

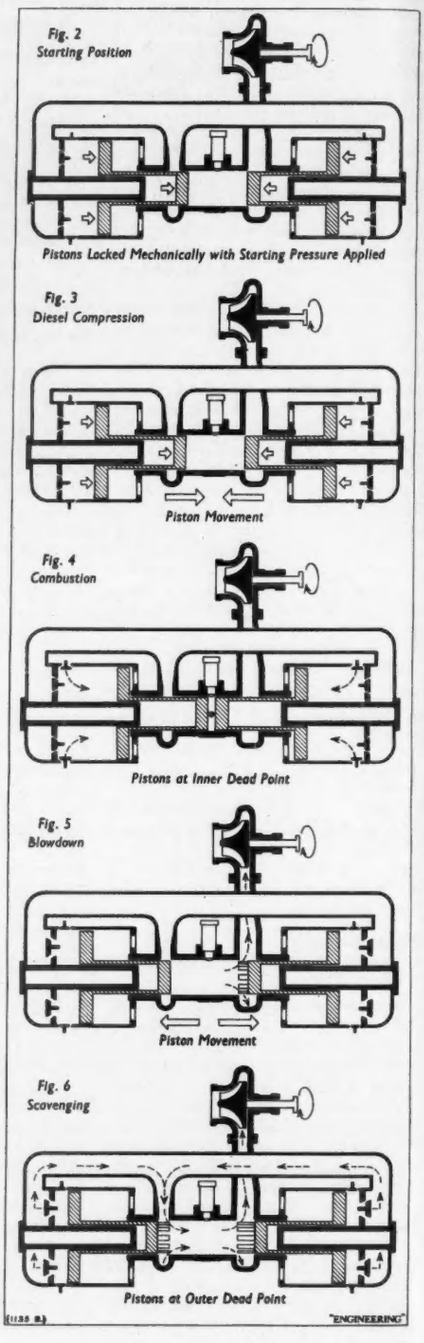
Simplicity of the cycle is preserved in the mechanical solution. For example, the main frame and compressor cylinders are cast as a single piece. The basic components of the Braun engine are—unlike those of rotary piston engines for example—of conventional design and subject to less severe operating conditions than in other engines.

The combination of simplicity and the use of conventional components greatly reduces the manufacturing costs. Many parts are either already available commercially, or can be manufactured on standard equipment. As a result a plant to produce the Braun engines can be realized with relatively small investment.

Servicing is simplified because the engine can be readily dismantled and reassembled. Since the centre portion of the frame is open, the diesel cylinder is readily accessible to standard tools, as are all other major parts of the engine.

It is generally accepted that outward-compression type engines have superior part-load control and throttle response to that of the inward-compression engine. In both types the inner dead-point of the piston travel varies only slightly with changing load, but the outer dead-point can vary over most of the length of the combustion cylinder intake ports.

An outward-compressing engine has better response because the load-change first affects the air *delivery* process—which is very sensitive to the length of stroke—while in an inward-compressing engine the relatively insensitive air *intake* process is the first to be affected. This means that for a given engine size the change in mass flow due to a change in stroke is much greater in the outward-compressing engine.



Figs. 2 to 6 (right) Schematic operating sequence of an outward compressing free piston engine.

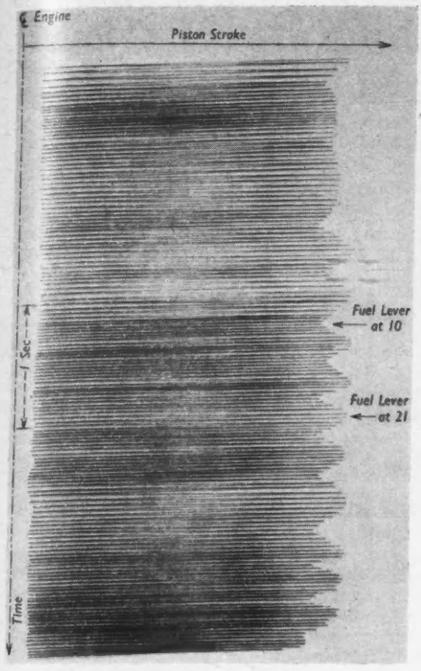


Fig. 7 Stroke diagram showing the engine's response to rapid variations in load.

The BR-3500 design fully utilizes the advantages of the outward-compression principle. The engine can be controlled between 100 and 10 per cent of full load solely by changing the fuel lever position. No recirculation, throttling or other control systems are required.

If the fuel lever of the engine, operating at full load, were to be shifted suddenly to the 40 per cent load position, the smaller amount of fuel injected would immediately produce a shorter outward stroke. Affecting the very sensitive delivery process, less air would be delivered to the combustion cylinder within half a cycle-time. Consequently, in the 40 per cent outer dead-point position of the pistons the residual air mass in the compressor cylinder would be larger than at the full load outer dead-point position.

Since the mass of air contained by the compressor cylinders at the inner dead-point is essentially constant, less fresh air can enter the compressor cylinders during the shorter 40 per cent load inward stroke.

Quick Recovery

As the full amount of air is contained in the compressor cylinders with the pistons at their inner dead-point, the engine is immediately ready after each cycle for a full-load stroke. With the absence of any flywheel effect, the engine response and recovery are outstanding.

The stroke diagram of Fig. 7, on which 40 strokes per second were recorded, emphasizes the characteristic quick recovery by the response of the outer dead-point to the fuel lever position. In this instance the lever was moved six times per second, making three full recoveries from full to part load and back to full load per second.

Another result of the engine characteristic is the fact that the BR 3500 can withstand up to four successive fuel injection failures without stalling. This is impossible in the inward-compression engines since, in order to obtain a high enough compression ratio in the diesel cylinder for the next combustion, the pistons have to reach the inner dead-point and therefore the compressor cylinders must complete their full delivery. All the energy supplied by the previous combustion is consequently absorbed by the compressor cylinder and the engine will stall.

In the outward-compression engine an injection failure will result in a shorter outward stroke and, since the compressor pistons will not go out far enough to deliver any air, the compressors will augment the bounce effect and return the pistons to an inner dead-point sufficient for combustion.

In a test, four successive injector failures were imposed on the engine, but satisfactory combustion occured when injection was restored on the fifth cycle, and the engine recovered. (Fig. 8).

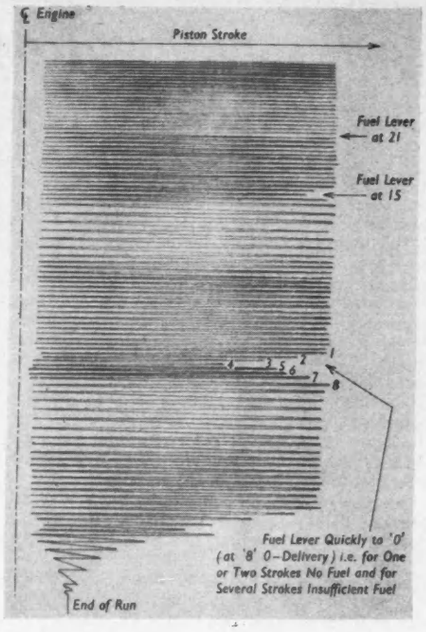

℄ Engine
Piston Stroke
Fuel Lever at 21
Fuel Lever at 15
1 2 3 4 5 6 7 8
Fuel Lever Quickly to '0' (at '8' 0–Delivery) i.e. for One or Two Strokes No Fuel and for Several Strokes Insufficient Fuel
End of Run

Fig. 8 Stroke diagram showing stall-free recovery of the engine after repeated failures of the injector.

Thermal Stresses

Another important aspect of engine operation is temperature distortion, which is minimized in the Braun engine over the entire range of operating conditions.

The open frame design of the outward-compression engine avoids the distortion problems encountered in the inward-compression engines. Furthermore, parts subject to thermal dimensional variations can " breathe freely."

The cylindrical centre frame basic to the inward design is exposed to relatively severe temperature conditions as it is used to store air at 450 to 500° F. Even more critical is the fact that this cylinder is irregular due to the penetration of exhaust and cooling ducts, fuel injection and starting equipment. The irregular shape results in uneven dimensional changes which can cause warping and may easily affect major engine parts. The open frame design eliminates distortion hazards.

Water cooling is used on the BR 3500 engines, but the open frame lends itself more readily to air cooling than do other designs. Air cooling would be particularly effective in northern climates where water-cooled engines cannot take advantage of the sub-zero temperature of the available heat-sink.

The weight of the 80 gas hp engine is approximately 400 lb, giving a weight to power ratio of 5 lb per gas hp. Gas hp rather than shaft hp is taken as reference because these engines are used primarily in compound power plants where the specific weight per shaft horse power depends greatly on the total power output, that is, the number of gasifiers feeding one turbine. In such an installation the weight of the turbine is much less than the weight of the gasifiers.

For example, a turbine and gasifier would weigh approximately 460 lb and would produce about 55 shp with a weight to power ratio of 8·5 lb per shp. If three gasifiers were operating the turbine, 180 shp would be developed by approximately 1,270 lb of equipment, reducing the weight to power ratio to 7 lb per shp. The weight to power ratio can be further improved.

Fuel consumption of this engine during tests at half load has been 0·38 lb per gas-hp hour. Work in progress on the combustion and injection equipment should reduce this to 0·35 lb per gas-hp hour and better. The specific fuel consumption curve is quite flat through the entire load range.

Braun has recently completed designing the BR 6000, a 200 gas-hp engine for automotive applications which will weigh only 600 lb as a result of the use of aluminium components. The predicted specific fuel consumption for this unit is below 0·33 lb per gas-hp hour.

The principles utilized in this latest design are particularly applicable to larger engines of 2,000 and more hp per cylinder. It is claimed these engines will operate with specific fuel consumption and weight to power ratios superior to those of diesel engines in the same power range.

300 MW Turbo-Generator Now in Service

A 300 MW turbo-generator is now in operation at Lakeview power station in Canada. As well as making claim to be the largest unit yet installed in the Commonwealth, it has an output 50 per cent greater than any other unit anywhere in the Commonwealth, including the UK.

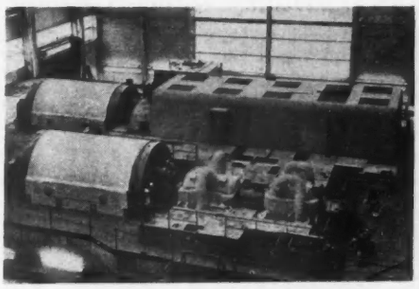
It is not, however, the largest machine ordered from the company, C. A. Parsons, who have six 500 MW units (and over) on their books. One of these, a 550 MW unit is under construction for Thorpe Marsh in Yorkshire. A 500 MW set is being erected for the Tennessee Valley Authority.

The 300 MW machine is the first of two ordered from the company by the Hydro-Electric Power Commission of Ontario. It is of cross-compound design, one line consisting of an HP and IP turbine driving a 150 MW generator at 3,600 rpm. The other line comprises a second IP turbine and two double-flow LP turbines driving a 150 MW generator at 1,800 rpm.

The operating steam conditions are 2,350 lb per sq. in, 1,000°F at the stop valve with reheating between the HP and IP cylinders to 1,000°F. The 60 cycle generators operate at 16,000 volts, 0·85 power factor and are hydrogen cooled. Each rotor is of the direct-cooled type operating in hydrogen at a pressure of 30 lb per sq. in.

Both generators are designed and have the necessary equipment to enable them to operate as synchronous condensers, when the generator rotors are disconnected from the turbine shaft (see ENGNG., 25 Aug., p. 238).

C. A. Parsons and Company Limited, Heaton Works, Newcastle upon Tyne 6.



This 300 MW turbo-generator can also operate as a synchronous condenser.

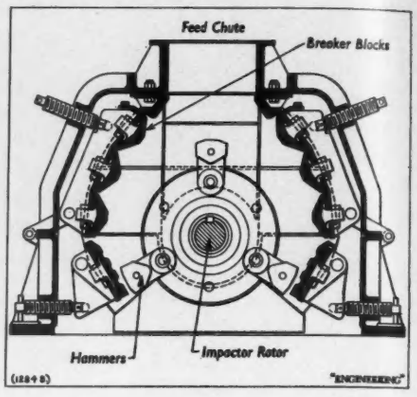
Reversible Rotor Reduces Wear in Crushers

Impactors with a reversible rotor are now being made by GEC (Engineering) Limited in a range having capacities of up to 1,500 tons per hour. GEC say that this is the first time crushers of this type have been made in the UK and they are particularly suitable for the refractory, metallurgical, lime and similar industries.

The main feature of this range—known as Pennsylvania impactors—is the fact, already mentioned, that the rotor is reversible. By systematic reversal of the rotor it is possible to balance wear between the two sets of breaker blocks and the two faces of each hammer on the rotor. This results in reduced maintenance costs as compared with non-reversible impactors which also have to be dismantled before the hammers can be reversed. As can be seen from the drawing, breaker blocks are fitted on both sides of the machine and the feed chute placed directly over the centre of the rotor.

Another important feature is the contour of the breaker blocks, which are shaped to give a cubical product at a high rate of reduction with minimum wear. On one of the two heavy-duty types of impactor available, the CD machine, the breaker blocks are individually adjustable so that as the faces wear they can be moved towards the hammer circle ensuring a constant output of a uniform size of product. The other heavy-duty type is the CF, which has fixed breaker blocks. For light duties, such as the handling of fertilizers and chemicals, types CDL and CFLL are available.

The frame of the impactor is fabricated from heavy steel sections and plates and is fitted with wear resistant liners for easy replacement. It is dust tight and can accommodate different heights of chute to suit the type of material being handled. As can be seen from the photograph, the breaker blocks are mounted on hinged covers which can be swung away to give free access to the inside of the unit.



The GEC range of impactors has a reversible rotor which makes it possible to balance wear between the two sets of breaker blocks and the two faces of each hammer on the rotor.

The rotor consists of a series of spaced discs keyed on to the shaft, with the wear resisting steel hammers held in the spaces by suspension bars. The number of discs and hammers depends on the duty and capacity of the crusher. Self-aligning bearings are used. The usual driving system employed is a direct-coupled motor, but a fluid drive or V belts can be fitted as alternatives. Variable speed control is possible with a direct-coupled motor or a fluid drive.

The impactors are generally used as secondary crushers, being fed with a primary crusher product of up to 18 in top size, reducing to about $\frac{1}{8}$ in depending on the size of the crusher and the setting of the breaker blocks. The material being handled affects the wearing life of the parts, but as an example, when handling limestone, a set of hammers can have a life of between 100,000 and 400,000 tons. Breaker blocks and frame liners can be expected to have a life three or four times as great.

GEC say that compared with hammermills the compactor has been proved to operate at 50 per cent reduction in costs on similar applications. They also say that when operating in closed circuit at low speed, it is superior to the conventional hammermill for materials of a friable nature.

GEC (Engineering) Limited, Fraser and Chalmers Works, Erith, Kent.

Changing the Shape and Size of a Damaged Tanker

After fire damage sustained at Milford Haven refinery on 8 July, 1960, Esso Petroleum's tanker "Esso Portsmouth" arrived at the Palmers Hebburn works of Vickers-Armstrongs (Shipbuilders) Limited for initial survey to determine the extent of repairs necessary. Preceded by a series of explosions, the fire had caused extensive damage to the vessel's hull and cargo tanks, the bridge structure, accommodation and deck fittings. Temporary repairs had been carried out at Milford Haven to allow the vessel to be towed to the Tyne.

Esso Portsmouth was drydocked at Swan Hunter and Wigham Richardson's yard at Wallsend and examination showed extensive damage to shell plating from stem to poop and most of the deck plating. This was especially bad in way of No. 3 port tank where the deck had been blown out a distance of about 4 ft. The welded seams and butts had remained intact even with such deformation.

Internal damage was serious between cargo tanks 2 to 10, where bulkheads, stringers and webs had been blown into adjacent tanks. The forecastle deck and 2nd deck forward were also severely damaged. The bridge structure was completely gutted by fire and beyond any form of repair. The heat of the fire had been so intense that the aluminium panels on the fore and aft gangway had melted away and a derrick which had been stowed on a crutch, had bowed down until it had touched the deck. Deck fittings and hatches were also severely damaged.

It was decided to cut out the middle section of the vessel between tanks 2 and 6 and replace it with a new midship section, rejoin the forward and after ends and finally join all three sections in drydock. The owners took the opportunity to increase the size of the tanker by installing an extra cargo tank in the new section which was built by Vickers at the Walker Naval Yard. This additional lengthening of the vessel involved the fitting of doubling straps to deck and shell to maintain longitudinal strength. Originally the tanker was 690 ft long, but after lengthening it was 730 ft. A new bridge structure was built over the existing poop house instead of amidships.

In Swan, Hunter's drydock, the existing vessel was cut in half and the new section towed from Vickers' into the drydock. The existing aft section—previously having been removed—was brought back and all three sections were accurately aligned prior to the joining up operation.

Getting Long Loads Round Sharp Bends

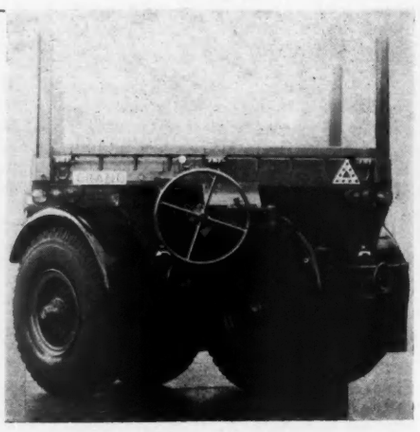
To give ease of movement around traffic islands and sharp bends, two 19-ton two-axle-in-line suspension bogies have been supplied by Cranes of Dereham to British Road Services for the carriage of indivisible loads of up to 35 tons.

Hand-steering mechanism is fitted to the bogies which make the degree of rear steering 40° in either direction. The loads are incorporated to connect the motive unit to the rear bogie by bolster and load location points at front and rear. The rear bogies are locked in position at right-angles to the fore and aft axis of the complete vehicle under normal running conditions.

When the unit is running light, the motive unit—normally a rigid vehicle—and bogie can be close coupled by a short central box section drawbar (the jockey wheel stabilizer being in the stowed position); or mounted on the platform of the rigid lorry, in which case the jockey wheel remains in the normal downward position.

Two Crane ball-bearing turntables are incorporated in the frame construction, and these give the easy action to the suspension to allow the 40° turn mentioned previously.

Cranes (Dereham) Limited, South Green Works, Dereham, Norfolk.



The degree of turning on these two-axle-in-line suspension bogies is 40° in either direction.

Disc Brakes: Power to Stop

Modern high performance cars exposed the cooling limitations of the drum brake. The disc brake, derived from aircraft practice, provided the answer, but its development necessitated the solution of many problems.

By Brian Lister

NEW innovations incorporated in the design of modern cars as a direct result of racing during recent years have been comparatively few but one — the caliper operated disc brake is now proving to be of considerable use to the ordinary motorist.

Disc brakes, however, are not a post-war invention, in fact one type was patented by Dr. F. W. Lanchester as early as 1902. They were also used on one or two cars up to 1939, including the AC in the early twenties, which had a brake on the overhead worm final drive.

The first full scale use of discs was on military equipment in the 1939-45 war. One of these was the Girling disc used on the Daimler armoured car. This was developed for special problems of space limitations, rather than thermal efficiency and it was a different conception to the caliper type brake with which we are so familiar today.

It was in fact a drum mounted on the hub of the vehicle; a disc was fitted inside the drum and the friction material was brought into contact with the faces of this disc by balls working in a ramped recess.

DRUMS INADEQUATE

The first post-war cars, in large scale production, to be fitted with disc brakes were the large Chrysler Crown Imperial models of the early 1950's. Here again these were not of the caliper type but instead had a cast, finned housing attached to the hub, machined on each inner vertical face. Within the housing were two pressure plates, carrying friction material on a spider, and this in turn was attached to the hub. The plates had ramps and balls between them and a rotational movement controlled by hydraulic cylinders forced the plates apart and on to the machined faces inside the housing.

In the thirties many high performance cars had wire wheels, narrow tyres, and cycle (or comparatively high) type wings, that allowed plenty of air to circulate around the drums.

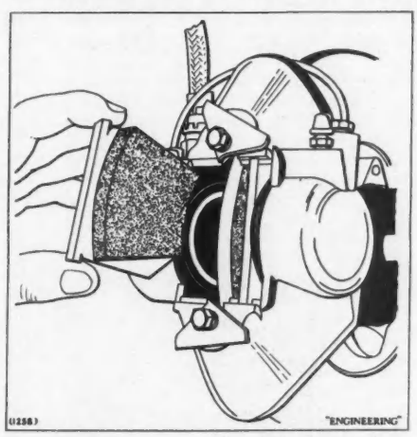
Post-war developments brought more pressed steel disc type wheels, wider tyres and all enveloping aerodynamic bodies. These post-war developments meant higher speeds, smaller wheels and better road adhesion, all of which added to the problems of heat. Drum brakes, which had begun to show their limitations before the war were now giving considerable trouble.

It is interesting here to note that two tyre manufacturers, namely Goodyear in the USA, and Dunlop in the UK, became involved in the manufacture of caliper disc braking systems, originally through their association with aircraft tyres and wheels. The caliper disc was considered suitable for aircraft, but not at this time for cars. This was due to the distortion that occurs on stub axles and shafts when a car corners. The disc under these circumstances runs out and knocks the pads back, causing the master cylinder, when it is applied, through the brake pedal, to have insufficient reserve fluid to bring the pads into contact, with the result that the brake pedal travels to the stops without having any braking effect.

The success of the C-type Jaguars which finished 1st, 2nd and 4th at Le Mans in 1953 was, no doubt, largely due to their disc brakes which permitted a drastic reduction in braking distances.

During 1952-3 Jaguars approached Girlings to see if they would design them a disc brake for their Le Mans cars.

Girlings felt that it would be wiser at this point, to wait for further developments of the hydrostatic design on which they were working. This design maintains the pads of the caliper in constant, slight rubbing contact with the disc, therefore requiring less hydraulic displacement to bring the pads into hard frictional contact with the disc. They offered Jaguar a three trailing shoe drum brake. Jaguar asked Girling to keep this special drum brake under development and in reserve, but said they preferred to use discs if possible. They also approached Dunlop,



Long distance racing demanded that pads be quickly replaceable. The Girling system was modified to facilitate replacement through the top of the caliper.

who placed their aircraft brake at their disposal. This was a three pad model (three pads on either side of the disc). It was found necessary to incorporate a servo pump in the system, because of the effects of distorting axles mentioned earlier. After intense development in which both Dunlop and Girling cooperated a system was perfected and used in the 1953 Le Mans cars.

Jaguar finished 1st and 2nd in this Le Mans race, and there is no doubt that considerable credit for this result must be given to the disc brakes. The winners speed for 1953 was 105·85 mph, compared with 96·67 in 1952 and 93·50 in 1951.

The breakthrough had begun.

After this race, development progressed at a tremendous pace. Jaguar continued using Dunlop brakes, but it was found that the time taken to replace the friction pads (over one hour) was a decided disadvantage in long distance racing.

One of the great advantages of the disc brake is the large area of metal constantly in the cooling air stream. But the lining pad area is smaller than with the drum brake, so that the wear is heavier. Clearly a system that enabled easy and quick replacements of the pads had to be devised.

A mechanic making adjustments to a disc brake on a Ferrari Grand Prix racing car.

A single pad caliper had been developed by Dunlop in the meantime and was being used by Austin Healey and Lister-Bristol cars amongst others. Girlings had now introduced their hydrostatic model, using a pad shaped to match a perfect segment of the disc it mated with. The pad was bonded to a steel backplate and the assembly could be removed through the top of the caliper in minutes, simply by removing the wheel from the car and a keep plate from the caliper itself. Replacement time came down to minutes.

EXPORT LEAD

Aston Martin decided to use a light alloy caliper version of this brake on their sports/racing cars and it helped the marque to win the 1,000 km event at Nurburgring three times. The Triumph TR3 was the first true production car to fit Girling discs. Dunlop also introduced a similar arrangement for pad removal to that used by Girling, but changed from circular pads to rectangular ones.

When the first moves were on to produce discs for the racing fraternity, chrome plated steel discs were used to ensure that there was none of the porosity usually associated with castings. However, cast iron was the obvious answer, if the cost of disc brake production was to fall. There were other good reasons for using castings, including the known performance of cast iron against various friction materials. Within a year or two foundries had achieved methods of making discs free from porosity and the cast iron disc is now standard on most systems.

Lockheed were doing their development work in racing with BRM. Mr. Tony Vandervell had decided to develop the Goodyear aircraft disc brake himself for use on his Vanwall racing car. At one time during its development titanium discs were tested, but they were not successful. One of the features of the Vanwall discs were that they were drilled radially to lighten them and possibly help cooling, but it is believed that this led to corrugations of the disc surface.

Goodyear still supply aircraft disc brakes, but there has been no enthusiasm for their use on motor cars in the USA.

The lead we have in this country has given us important export orders, and these are still increasing. Amongst foreign companies using them now on certain of their passenger cars are Mercedes-Benz, Fiat, Alfa Romeo and Maserati.

Practically all British manufacturers are now offering discs as standard or special equipment on many of their models. This revolution in braking technique has occurred in seven years. Much of the important research work has been undertaken by manufacturers engaged in racing, and most people who have driven a high performance car with disc brakes will consider that motor racing has justified its existence on this issue alone.

Plain Words

By Capricorn

LET'S face it: engineering is a relentless juggernaut. It places the community before the individual.

It brings the fruits of the world to the tables of the masses. It permits them the luxury of fickle, fast-changing fashions in the clothes they wear. It gives them homes of controllable environment and instrument-like precision in the regulation of lighting and cooking. It blurs the old distinction between luxuries and necessities by providing personal transport, personal music, and personal communication networks at prices which the majority can afford. Engineering does all these things and more, and if you are in engineering you serve this bountiful service, but if, as an individual or a consumer, your needs or wants don't tally with those of the majority, or if the march of progress threatens to trample on your cherished property, institutions or ideals, then you will be sacrificed under the wheels of the juggernaut. High standards of living are yours to enjoy, but if they don't happen to be your standards you can lump it.

For the sake of our wealth and affluence we put up with these restrictions on our liberty of choice. We accept the system because without doubt it has enriched us. So long as it doesn't hurt us or offend us on a personal matter, we hardly notice its steam-roller nature—until one day we see it is about to run over us. I have not had this experience, but every day the newspapers report that someone, somewhere, is opposing a development or project which offends him. An inquiry is held into a plan to build a multi-storey car park; there are protests over the erection of cooling towers 350 ft high; miners campaign against the closing of uneconomic collieries; proposals to construct a ring road are held up while local residents organize an opposition; Sussex downsmen are up in arms over a plan to erect a television mast on the downs; old railways are saved from extinction by the enthusiastic labours of amateur railwaymen; and vain efforts are made to save the Doric arch at Euston.

Do we in Britain suffer more than other nations from this resistance to change? I do not know, but I am sure we cannot afford this obstruction to our efforts. We cannot afford the frustration to those who are trying to get things done. By all means move an historic Tudor house to a new site where it won't be in the way of road traffic—if you can raise the £800 required to cover the cost. Put old locomotives in a railway museum and collect shillings from the visitors. Preserve the façades of Carlton House Terrace.

For the instinct of preservation is strong in Britain—as strong as the instinct of opposition. But first weigh the cost to the community. Modern industry is geared to the insatiable appetites of the masses. They pay the piper and they call the tune.

Letters to the Editor

Electronic Computers Benefit India

SIR, I note that a recent Marketing report in your columns (ENGNG., 1 Dec., '61, p. 721) announces the installation of an IBM 1401 computer system in the Bombay office of Standard Vacuum Oil Company, claiming to be the first computer system installed in India.

It is, to my mind, an unjustifiable slight on the rate of advance of the country to suggest that only now has the electronic computer found application in one of its industries, and that the subsidiary of an outside firm. My own company installed a National-Elliott 803 at Hindustan Aircraft Limited in Bangalore over six months ago, and the Indian Statistical Institute is known to have been using a system of ICT design since 1955.

The Indian economy may be hard pressed but Indians know the right way to improve productivity and make the most of their resources.

Yours faithfully,
F. S. ELLIS,
Computing Division.

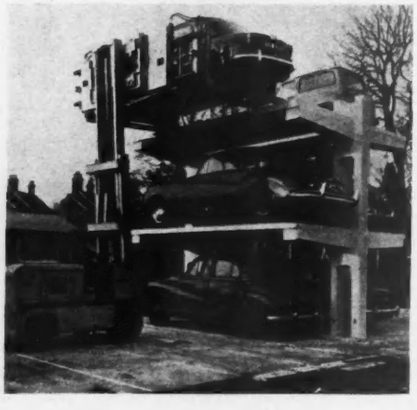
Elliott Brothers (London) Limited,
Borehamwood, Hertfordshire.
11 December, 1961.

Cheaper Car Parking

SIR, In your current issue you feature an Impact note on the car-parking problem which deals with the inquiries recently made by the Roads Campaign Council ("Too Few Spaces for Cars," ENGNG., 8 Dec. '61, p. 729).

It is interesting to note that the Campaign Council came to the conclusion that the average cost of building off-street parking was about £300 per car space.

As the sole sales agents for Kingsbury Fitch and Company Limited, of Haywards Heath, whose car parking system is illustrated here,



An example of the Kingsbury Fitch car parking system. Later models feature three-shelf units.

we should like to draw your attention to the fact that the Fitch system costs, on an average, between £150 and £200 per car space (including the cost of the fork-lift truck), which is far below the Council's figure.

Further, it is an uncomplicated system and one which cannot break down as has been found in certain systems—with the inconvenience that results to both user and proprietor. The system has the advantage that cars can be packed tightly, end to end; thereby making the optimum use of the space available.

The latest models of this system feature a three-shelf ground-floor system of extremely simple design, constructed in precast concrete. (The illustration shows an earlier two-shelf unit.) Further, one of its main features is that it can be dismantled, should the proprietor find that his original calculations re custom of the park have not been borne out in practice.

It can therefore be installed elsewhere, perhaps at another filling station or similar site. Units can also be built with the shelves cantilevered from the wall of an office or factory.

Yours faithfully,
PETER J. GARRINI,
Director.

Peter J. Garrini and Associates Limited,
Edgware, Middlesex.
12 December, 1961.

Events in Advance

Exhibitions and Conferences

Arranged in chronological order

Furniture Exhibition, 13th Annual.—Mon., 29 Jan., to Sat., 10 Feb., at Earls Court, London SW5. Organized by B.F.M. Exhibitions Ltd., 17 Berners Street, London W1. Tel. LANgham 5115.

Amusement Trades Exhibition, 18th.—Tues., 30 Jan., to Thurs., 1 Feb. at the Royal Horticultural Society's New Hall, Greycoat Street, London SW1. Organized by Amusement Trades Exhibitions Ltd., 19 Charing Cross Road, London WC2. Tel. WHItehall 2524.

Furniture Fair, International.—Wed., 31 Jan., to Sun., 4 Feb., in Cologne. In the United Kingdom apply to the Du Mont Publicity Co., Ltd., 18 Quenesberry Place, London SW7. Tel. KENsington 1700.

Toy Fair, Ninth British.—Wed., 31 Jan., to Tues., 6 Feb., at the Bedford, Grand and Metropole Hotels and the Corn Exchange, Brighton. Organized by British Toy Fairs (International) Ltd., 94 Hatton Gardens, London EC1. Tel. CHAncery 9158.

Mechanical Equipment for Sewage Purification Works, Symposium.—Thurs., 1 Feb., at 1 Birdcage Walk, London SW1. Organized by the Hydraulic Plant and Machinery Group of the Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1. Tel. WHItehall 7476.

Canada Boat Show, Fourth.—Fri., 2 Feb., to Sat., 10 Feb., at the Automotive Building, Exhibition Park, Toronto. Apply to the Canadian National Sportsmen's Show, 85 King Street East, Toronto 1, Ontario, Canada.

Sports and Boat Show, National.—Fri., 2 Feb., to Sun., 11 Feb., at Cow Palace, San Francisco. Organized by the San Francisco National Sports and Boat Show Inc., 325 Pacific Avenue, San Francisco 11, California, USA.

American Institute of Chemical Engineers, National Meeting.—Sun., 4 Feb., to Wed., 7 Feb., in Los Angeles. Apply to Mr. G. C. Szego, programme chairman, Space Technology Laboratories, P.O. Box 95001, Los Angeles 45, California, USA.

Canadian Hardware Show, 57th Annual.—Mon., 5 Feb., to Thurs., 8 Feb., in the Exhibition Park, Toronto. Apply to the Show Manager, Canadian Retail Hardware Association, 290 Merton Street, Toronto 7, Ontario, Canada.

Gifts and Fancy Goods Fair, International.—Mon., 5 Feb., to Fri., 9 Feb., at Blackpool. Organized by Trade Promotion Services Ltd., St. Dunstan's House, Carey Lane, London EC2. Tel. MONarch 0871.

Swedish Boat Show.—Thurs., 8 Feb., to Sun., 18 Feb., at Gothenburg. Organized by the A.B. Svenska Batutstallningen, 38 Stampgatan, Gothenburg, e, Sweden.

Toy Fair, International.—Sun., 11 Feb., to Fri., 16 Feb., in Nuremberg, Germany. In the United Kingdom, apply to Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London EC4. Tel. CENtral 5050.

Agriculture and Agricultural Machinery Exhibition, 42nd.—Sun., 11 Feb., to Sun., 18 Feb., in Brussels. Apply to the secretary-general, Salon de l'Agriculture, 29 Rue de Spa, Brussels.

Leather Goods Industries Fair.—Mon., 12 Feb., to Fri., 16 Feb., at Mount Royal Hotel, London, W1. Organized by the *Leathergoods Trade Journal*, 15 Cursitor Street, London EC4. Tel. CHAncery 4001.

Scottish Dairy Show.—Tues., 13 Feb., to Sat., 17 Feb., at the Kelvin Hall, Glasgow. Organized by the Glasgow Agricultural Society, 82 Gordon Street, Glasgow C1. Tel. City 3727.

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters town are held there unless otherwise stated.

British Association for Commercial and Industrial Education

LONDON
"Human Implications of Mechanization in the Office," by A. J. Platt. London and Home Counties Group. Mullard House, Torrington Place, WC1. Tues., 2 Jan., 2.30 p.m.

British Institution of Radio Engineers

LONDON
"Data Transmission": symposium—comprising "Telephone Circuit Evaluation for Data Transmission," by K. L. Smith, J. Bowen and L. A. Joyce; "Modulation Systems for Data Transmissions," by A. P. Clark; "Comparison of PM and FM for Serial Data Transmission over Telephone Lines," by F. G. Jenks and D. C. Hannon; "Data Collection and Distribution," by D. J. Dace; "Error Correction in Data Transmission Systems," by E. R. Aylott and E. S. Simmonds; and "Recent Developments in Data Transmission," by K. L. Smith. London School of Hygiene, and Tropical Medicine, Keppel Street, WC1. Wed., 3 Jan., 10 a.m.
CARDIFF
"Test Equipment for Television Transmission Links," by L. A. Tanner. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 10 Jan., 6.30 p.m.

Building Centre

LONDON
"Sanitary Fittings for Hospitals," Discussion, to be opened by W. Fowler Howitt and P. Le Fleming. Wed., 10 Jan., 6 p.m.

Combustion Engineering Association

LEEDS
"Liquid Petroleum Gas in Industry," Discussion, to be opened by D. I. Thompson. Griffin Hotel, Boar Lane, Leeds. Tues., 9 Jan., 2.30 p.m.

Diesel Engineers and Users Association

LONDON
"Reconditioning High-Speed Automotive Diesel Engines," by J. W. Wicks. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 18 Jan., 2.30 p.m.

Illuminating Engineering Society

LONDON
"Lighting for Inspection," by H. E. Bellchambers and S. M. Phillipson. Federation of British Industries, 21 Tothill Street, SW1. Mon., 8 Jan., 6 p.m.
NOTTINGHAM
"Lighting for Crime Detection," by C. H. Edlin. Nottingham Centre. Electricity Centre, Carrington Street, Nottingham. Thurs., 4 Jan., 6 p.m.
STOCKTON-ON-TEES
"An Approach to Exterior Lighting," by G. P. Cundall. Newcastle upon Tyne Centre. Vane Arms Hotel, Stockton-on-Tees. Tues., 9 Jan., 6.15 p.m.

Institute of Marine Engineers

LONDON
"Motorship Auxiliary Machinery," by H. Taylor. Student Lecture. Mon., 15 Jan., 6.30 p.m.
MANCHESTER
"Trials and Operation of the Gas Turbine Ship Auris," by R. M. Duggan and A. T. O. Howell. Merseyside and North Western Section. Engineers' Club, Albert Square, Manchester 2. Mon., 15 Jan., 6.45 p.m.

Institute of Metals

LONDON
"New Methods of Powder Generation," by K. M. Spring. London Local Section. Thurs., 4 Jan., 6.30 p.m.
OXFORD
"Selling a Metal: The Technical Aspects of Developing New Outlets," by M. Bridgwater. Oxford Local Section. Cadena Café, Cornmarket Street, Oxford. Tues., 9 Jan., 7.15 p.m.

Institute of Petroleum

LONDON
"The Economics of Tanker Design," by I. B. Blackwood. Wed., 3 Jan., 5.30 p.m.

Institute of Road Transport Engineers

BIRMINGHAM
"Measurements in Engine Development," by R. W. Millington. Midlands Centre. Engineering and Building Centre, Broad Street, Birmingham 1. Tues., 9 Jan., 7.30 p.m.
BRISTOL
"Alternating-Current Generating Equipment for Transport Vehicles," by J. A. Cook. Western Centre. Royal Hotel, Bristol. Tues., 9 Jan., 7.15 p.m.
HORSHAM
"Turbocharging the High Speed Diesel Engine," by R. A. Tytler. Southern Centre. Black Horse, Horsham. Wed., 10 Jan., 7.30 p.m.

Institution of Agricultural Engineers

LONDON
"The Rig Testing of Agricultural Machinery," by E. Lang. Tues., 9 Jan., 6.45 p.m.
GLASGOW
"Force Measurement in Agricultural Engineering," by D.W. Tanner. Scottish Branch. West of Scotland Agricultural College, 6 Blythswood Square, Glasgow. Wed., 10 Jan., 7.30 p.m.

Institution of Civil Engineers

LONDON
"Selsey Coast Protection Scheme," by Jack Duvivier. Tues., 9 Jan., 5.30 p.m.
"Construction Methods and Problems of Tall Buildings;" Discussion, to be introduced by J. D. Bibby. Thurs., 11 Jan., 5.30 p.m.

Institution of Electrical Engineers

LONDON
"Transmission of Power at High Voltages," by F. J. Lane. Fourth Hunter Memorial Lecture. Thurs., 4 Jan., 5.30 p.m.
"Membranes"; Discussion, to be opened by Dr. H. Davson. Medical Electronics Discussion Group. Fri., 5 Jan., 5.30 p.m.
"A Linear Transducer of High Accuracy," by P. C. F. Wolfendale. Measurement and Control Section. Tues., 9 Jan., 5.30 p.m.
"Tests of Three Systems of Bandwidth Compression of Television Signals," by G. F. Newell and W. K. E. Geddes. Electronics and Communications Section. Wed., 10 Jan., 5.30 p.m.
"The Fourth Edition of the Regulations for the Electrical Equipment of Ships"; Discussion, to be opened by G. O. Watson. Utilization Section. Thurs., 11 Jan., 5.30 p.m.
ABERDEEN
"Sphere-Caps," by Dr. E. Kuffel. North Scotland Subcentre. Robert Gordon's Technical College, Aberdeen. Fri., 12 Jan., 6 p.m.
BELFAST
"Technical and Economic Aspects of the Supply of Reactive Power in England and Wales," by W. Casson and H. J. Sheppard. Northern Ireland Centre. David Keir Building, Queen's University, Stranmillis Road, Belfast 9. Tues., 9 Jan., 6.30 p.m.
DUNDEE
"Sphere-Caps," by Dr. E. Kuffel. North Scotland Subcentre. Electrical Engineering Department, Queen's College, Dundee. Thurs., 11 Jan., 6 p.m.
BIRMINGHAM
"Expanding Horizons in Communications," by D. A. Barron. Faraday Lecture. South Midland Centre. Town Hall, Birmingham. Tues., 2 Jan., 7 p.m.
GLASGOW
"A Dynamic Model for Studying the Behaviour of the Overhead Equipment Used in Railway Traction," by D. S. Farr, H. C. Hall and Dr. A. L. Williams. South West Scotland Subcentre. Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow C2. Wed., 10 Jan., 6 p.m.
LOUGHBOROUGH
"A General Theory of Depreciation of Engineering Plant," by D. Rudd. East Midland Centre. Loughborough College of Further Education, Loughborough. Tues., 9 Jan., 6.30 p.m.
NEWCASTLE UPON TYNE
"Transmission of Power at High Voltages," by F. J. Lane. Fourth Hunter Memorial Lecture. North Eastern Centre. Literary and Philosophical Society, Westgate Road, Newcastle upon Tyne. Mon., 15 Jan., 6.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Estimating Preliminary Dimensions in Ship Design," by D. G. M. Watson. Tues., 16 Jan., 6.30 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"Design of Packaged Boilers and Automatic Stokers," by R. D. Northcote. Birmingham Branch. Engineering and Building Centre, Broad Street, Birmingham. Tues., 9 Jan., 6.30 p.m.
BRISTOL
"Applications of Pneumatic Controls to Air Conditioning, with Special Reference to High-Velocity Air Conditioning," by G. F. Brown. South Western Branch. RWA School of Architecture, Bristol. Tues., 2 Jan., 6.30 p.m.

Institution of Highway Engineers

LEEDS
"Motor Maintenance," by P. H. Meacock. Yorkshire and Lincolnshire Branch. Griffin Hotel, Leeds. Thurs., 11 Jan., 7 p.m.

Institution of Mechanical Engineers

LONDON
"Wear of Rubbing Electrical Contacts," Discussion. Lubrication and Wear Group. Wed., 3 Jan., 6 p.m.
"The Small Gas Turbine," by Dr. John H. Weaving. Nominated Lecture. Automobile Division. Tues., 16 Jan., 6 p.m.
BIRMINGHAM
"Machine Tool Research, Design and Utilization," by Dr. D. F. Galloway. Repetition of the James Clayton Lecture. Midland Branch. James Watt Memorial Institute, Great Charles Street, Birmingham. Thurs., 4 Jan., 6 p.m.
BRISTOL
"The Design, Commissioning and Operation of Blyth 'A' Power Station," by A. E. Powell and E. Forth. Western Branch. Engineering Laboratories, University Walk, Bristol. Tues., 9 Jan., 7 p.m.
MANCHESTER
"Hovercraft," by W. A. Pennington. North Western Branch. Engineers' Club, Albert Square, Manchester. Thurs., 11 Jan., 6.45 p.m.
NEWCASTLE UPON TYNE
"An Experimental Study of the Flow Conditions and Pressure Drop of Steam-Water Mixtures at High Pressures in Heated and Unheated Tubes," by R. W. Haywood, G. A. Knights, G. A. Middleton and J. R. S. Thom. North Eastern Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 8 Jan., 6 p.m.

Institution of Plant Engineers

LONDON
"Fire Research: Causes and Control," by Dr. F. E. T. Kingman. Joint Meeting with the Institution of Fire Engineers. Royal Society of Arts, John Adam Street, Adelphi, WC2. Tues., 9 Jan., 7 p.m.
COVENTRY
Open Discussion Meeting. Birmingham Branch. Hotel Leofric, Coventry. Thurs., 4 Jan., 7.30 p.m.
EDINBURGH
"Design, Development and Certification on Medium-Voltage Heavy-Duty Switch and Control Gear," by Dr. E. H. Norgrove. Edinburgh Branch. 25 Charlotte Square, Edinburgh. Tues., 9 Jan., 7.30 p.m.
SOUTHAMPTON
"Engineering Education and Training"; Discussion. Southern Branch. Polygon Hotel, Southampton. Wed., 3 Jan., 7.30 p.m.

Institution of Production Engineers

LONDON
"Thread and Spline Rolling"; Discussion. London Graduate Section. Wed., 10 Jan., 7.15 p.m.
"Education for Industry," by E. C. Merrick. Royal Aeronautical Society, 4 Hamilton Place, W1. Thurs., 11 Jan., 7 p.m.
DONCASTER
"British Standards," by Dr. H. M. Glass. Doncaster Section. Technical College, Waterdale, Doncaster. Tues., 9 Jan., 7 p.m.
WOLVERHAMPTON
"Recent Developments in Automatic and Semiautomatic Welding," by L. H. Morgan. Wolverhampton Section. Wolverhampton and Staffordshire College of Technology, Wolverhampton. Wed., 3 Jan., 7.15 p.m.

Institution of Structural Engineers

LONDON
"Structural Engineering Aspects of the Millbank Tower Block, London," by Colin Davies. Thurs., 11 Jan., 6 p.m.
BELFAST
"Design and Construction of a Shell Roof," by S. O. Morton. Northern Ireland Branch. Queen's University, Belfast. Tues., 9 Jan., 6.30 p.m.
MIDDLESBROUGH
"Engineering Support to the Christmas Island Nuclear Tests of 1958," by Brigadier R. B. Muir. Northern Counties Branch. Joint meeting with the local branch of the Institution of Civil Engineers. Cleveland Scientific and Technical Institution, Middlesbrough. Wed., 10 Jan., 6.30 p.m.

Leeds Metallurgical Society

LEEDS
"Developments in Powder Metallurgy," by Dr. L. Harrison. University Staff House, University Road, Leeds. Wed., 17 Jan., 6.30 p.m.

Liverpool Engineering Society

LIVERPOOL
"Epicyclic Gearing for Industrial and Marine Use," by P. M. Woodbridge. Joint meeting with the local section of the Institute of Marine Engineers. Wed., 10 Jan., 6 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
"Design of the Canberra," by J. West. Neville Hall, Westgate Road, Newcastle upon Tyne. Fri., 12 Jan., 6.15 p.m.

North East Metallurgical Society

MIDDLESBROUGH
"Metals in the Home," by J. H. Gittus. Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough. Tues., 16 Jan., 7.30 p.m.

Radar and Electronics Association

LONDON
"Digital Telemetering," by J. B. Richardson. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 11 Jan., 7 p.m.

Reinforced Concrete Association

LIVERPOOL
"Formwork and Concrete Finishes," by C. Parry. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Tues., 9 Jan., 6.30 p.m.
MANCHESTER
"Formwork and Concrete Finishes," by C. Parry. North Western Branch. College of Technology, Sackville Street, Manchester. Mon., 8 Jan., 6.45 p.m.

Sheffield Metallurgical Association

SHEFFIELD
Annual General Meeting of the Methods of Analysis Group and the Presidential Address of the New Chairman. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 9 Jan., 7 p.m.

Society of Instrument Technology

LONDON
"A Review of Digital Computer Control Applications," by E. M. Grabbe. Data Processing Section. Manson House, 26 Portland Place, W1. Wed., 10 Jan., 7 p.m.
LIVERPOOL
"The Versatility of the D.P. Cell," by A. H. Isaac. Liverpool Section. Industrial Centre, Merseyside and North Wales Electricity Board, Paradise Street, Liverpool. Thurs., 11 Jan., 7 p.m.

Tyne Wear Metallurgical Association

NEWCASTLE UPON TYNE
"Some Aspects of Electrochemical Corrosion," by Dr. T. P. Hoar. Metallurgical Department, King College, Haymarket, Newcastle upon Tyne. Tues., 9 Jan., 6.30 p.m.

Women's Engineering Society

LONDON
"Bluebird Project," by D. Stevens. London Branch. Hope House, 45 Great Peter Street, SW1. Mon., 8 Jan., 7 p.m.

British Association for Commercial and Industrial Education. Apply to T. H. J. Field, British Road Services, Melbury House Melbury Terrace, Marylebone, London NW1. (PADdington 1161)
British Institution of Radio Engineers, 9 Bedford Square, London WC1. (MUSeum 1901)
Building Centre, 26 Store Street, London WC1. (MUSeum 5400)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London SW1. (BELgravia 3291)
Institute of Petroleum, 61 New Cavendish Street, London W1. (LANgham 3583)
Institute of Road Transport Engineers, 1 Cromwell Place, South Kensington, London SW7. (KENsington 3744)
Institution of Agricultural Engineers, 6 Queen Square, London WC1. (TERminus 0140)
Institution of Civil Engineers, Great George Street, London SW1. (WHITehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2. (COVent Garden 1871)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street London SW1. (ABBey 3891)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James Park, London SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1. (BELgravia 4535)
Leeds Metallurgical Society. Apply to Dr. P. R. Beeley, The University, Leeds.
Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool 2. (Central 3717)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. (Newcastle 20289)
North East Metallurgical Society. Apply to Mr. W. H. Lowther, 5 Priestfield Avenue, Ladgate Lane, Middlesbrough, Yorkshire.
Radar and Electronics Association, 45-47 Mount Street, London W1. (GROsvenor 4477)
Reinforced Concrete Association, 94-98 Petty France, London SW1. (ABBey 4504)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7 (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London W1. (LANgham 4251)
Tyne Wear Metallurgical Association. Apply to Mr. J. K. O'Hanlon, C. A. Parsons and Co., Ltd., Fossway, Newcastle upon Tyne 6.
Women's Engineering Society, 25 Foubert's Place, London W1. (GERrard 5212)

Human Element

First Residential Course for Shop Stewards

As INDUSTRY grows vaster, more remote and more "organized" so a greater strain is thrown upon shop stewards as the vital on-the-spot link in communications between management and managed. Last week the first ever five-day residential course for shop stewards was held at Great Missenden Abbey, in Buckinghamshire, to give a group of 16 of them an opportunity of studying and discussing the practical problems of shop stewardship.

The course was organized by the Slough College of Further Education (with the backing of the Buckinghamshire Education Committee), and the syllabus was drawn up by Mr. Graham Thomas, of their department of management. Over the past ten years or so this department has developed a high reputation for its management and supervisory courses. After the Minister of Labour's discussions with both sides of the motor industry last spring the idea of holding this course for shop stewards was conceived.

With the importance of communications as the central theme of the programme, the lecture and discussion subjects included trade union principles and rules, workshop relations, negotiating procedures, industrial law, strike action, industrial injuries, labour turnover and work study. In addition to Mr. Thomas, the lecturers included Mr. Walter Padley, M.P. (President of the Union of Shop, Distributive and Allied Workers), and Mr. Arthur Marsh and Mr. John Ireland (both of Oxford University's Extra Mural Delegacy).

The sixteen course members were elected by their fellow shop stewards in their own companies and, in the event, were drawn from the Transport and General Workers Union, the Amalgamated Engineering Union, the General and Municipal Workers Union, the Amalgamated Society of Woodworkers and the Typographical Association. They came from 10 firms within a 25 miles or so radius of Slough, and one of the important aspects of the course was that they were able to exchange ideas and experience with other shop stewards from other unions and other firms. Between them, they had a total of nearly 200 years' service as shop stewards (though some were young men whose own service could not have been very lengthy) and so there was plenty of experience to share.

Wide Support

In the case of most of them, their 10 guinea fees and their wages were paid by their employers, but an example of the active union support for the course was the fact that the fees and wages of three course members were paid by local trade councils. The trade unions at national level also gave the course their blessing, as did the Regional Controller for the Ministry of Labour, Mr. H. P. Bond.

By the half-way stage in the course there was no shadow of doubt that it would be every bit as successful as its organizers had dared to hope. If their employers could have seen the course members at first hand enthusiastically attending lectures and discussions for virtually twelve hours a day and then continuing unofficial discussion on the course into the early hours of each morning, then they would have felt assured that their expenditure of ten guineas and one week's wages was one of the best investments they had ever made in terms of good human relations.

It would have been an eye-opener for many people to have heard a man who had been a shop steward for over 30 years say that now, for the first time in his trade union career, he felt "fully conversant with industrial negotiating procedures." This was not an isolated point of view and, equally significantly, most of the course members regarded the course as a starting point from which they intended to develop a wider knowledge of industrial relations on their own account.

As Mr. Padley said during the week, it is very much to be hoped—indeed, it is nationally vital—that other local authorities follow the Slough and Buckinghamshire example and put on similar courses. Certainly, there is now a demand for more of them in the Slough area itself. When one considers that, on a TUC estimate, there are something like 200,000 shop stewards in this country there is obviously an insatiable demand for such courses.

All local authorities may not have the good fortune of possessing a residential centre like Great Missenden Abbey—made available to this course by the Warden, Mr. G. Talbot-Griffiths—but the many local technical colleges which now put on management courses could do industry a further great service by arranging courses for shop stewards. They have the organizing and the teaching facilities and, being able to stand outside the inter-action of everyday contact between management and unions, they are well placed to handle courses of this nature in an objective, liberal and, perhaps most important of all, unsuspected manner.

Must Engineers Become Administrators?

Last October, in his Presidential Address to the Institution of Electrical Engineers, Mr. G. S. C. Lucas pointed to the continuing growth of big firms as one of the most significant current trends in the electrical industry. This month, in a paper given to the London Graduate and Student Section, he considered the implications of this situation for the young engineer.

In particular, he tackled the questions of whether (*a*) the engineer loses his freedom and identity in a large firm; (*b*) the young engineer must move into administration to achieve real success; and (*c*) whether he is equipped to move into administration anyway.

Broadly speaking, Mr. Lucas's answer on the first question was that size of firm need not affect the engineer's identity and freedom because both are related to the size of a working section, and sections do not usually vary in size in relation to that of the firm. What does vary is the number of sections, and the increased resources of large firms, in fact, increase the scope and opportunity for engineers.

On the relative attractions and merits of careers in engineering and in management, he advocated that a young man should always have before him the possibility of moving into administrative management but that once immersed in technical work he is less likely to want to move from it. In order to reduce the possibility of dissatisfaction with a purely engineering career, thought Mr. Lucas, industry should give individual technical appointments the same status and salary as management appointments.

Unfortunately, however, status is more difficult to satisfy than salary because there is no generally accepted equivalent to the word "manager" and because organization charts inevitably tend to amplify the importance of management. Mr. Lucas looked forward wistfully to the day when the good technical man might no longer be interested in such baubles as titles. In this context he quoted the example of the "Mr." used by surgeons, though one's own observation is that the surgeon covets his "Mr." precisely because, within his profession, it gives him a status above a mere "Dr."

Another point made by the President was that technical recruitment should always be planned at least ten years ahead. Because of the difficulty of anticipating exact technical developments over such a period, it is therefore necessary, he said, to look for recruits who are broadly educated and trained. If this is so, perhaps the initial specifications for technical and management material are not so very different. Unfortunately, the current controversy about management education demonstrates that one or both of these specifications is not met in practice.

High Jinks at the Civils

At their last meeting before Christmas, the Association of London Graduates and Students of the Institution of Civil Engineers held a discussion (it was mis-styled a "debate") on "The Role of the Institution in the Profession and Contemporary Society." If this sounds like the basis of profound philosophizing on the lines of "why civil engineers?" or "the civil engineer's debt to society" or, perhaps, "society's debt to the civil engineer," then the point must be made immediately that the discussion was on a much more domestic—and sometimes abandoned—level.

There were two inter-related themes running through the discussion—(a) how can we make the Institution a better place for its members? and (b) how can we convince more of the outside world that we are a worthwhile body?

An early speaker urged that the Institution "should become a trade union of engineers," by which he seemed to mean that civil engineers could best protect their interests by establishing some kind of closed shop. His listeners seemed to have an equally limited notion of the function of trade unions for they seemed quite swayed by the counter-argument of the next speaker who needed only to say "trade unions!" in a shocked tone of voice and smile happily. One hopes that these senior engineers of tomorrow were at this point concealing a more serious understanding of the role of the unions.

A number of speakers subscribed to the view that the Institution would be stimulated by being developed further as a residential and luncheon club, and one enterprising member put forward a grandiose scheme for tearing down the existing building and building a massive sky-scraper, *à la Shell*, on its valuable site. The Institution might then, he advocated, occupy the top six or so floors (there must surely be something psychologically significant about his choice of the *top* six floors) and rent off the remaining floors at a massive profit.

Another member, however, had a word of warning on the idea that the Institution should establish a luncheon club. Any civil engineer worth his salt, he pointed out, would be unable to patronize such a club because his time would be taken up by commercially profitable luncheon *tête-à-têtes* at fashionable West End clubs with "Lord So-and-so and Mr. So-and-so." This, one must take it, is a young man to watch—particularly if you happen to be "Lord So-and-so" or "Mr. So-and-so."

Amalgamation

Unavoidably, another subject thrashed out at length was amalgamation. On the whole, most speakers were for amalgamation of the engineering institutions, though they recognized that the administrative difficulties involved and the unwillingness of some older members to agree to any amalgamation of the strings of letters after their names (an outlook for which, by and large, the meeting had a healthy disrespect) would probably mean that federation must precede amalgamation.

Publicity was another subject approached with the *verve* of youth. Some members wanted to throw out professional inhibitions about advertising, and almost to a man (and one woman) they were all for the Institution pursuing an active public relations campaign, the need for which was underlined a little ironically by the fact that many speakers did not know that the Institution already has a public relations officer.

Perhaps the association chairman summed up the feeling of the meeting on this point succinctly when he said that the only difference between advertising and public relations is that you pay for the former. Therefore, he concluded, the economic and strategic thing to do is to get cut-rate advertising through a public relations set-up. One dark night he is going to meet a public relations officer. . . .

Another Record Mile?

Herb Elliott, the Aussie at Cambridge who can run a mile faster than anyone else, might be setting up a different sort of mile record. There is a possibility that he might be the pilot in the attempt by post-graduates of Southampton University at flying a mile in a man-powered aircraft.

The aircraft being developed at Southampton (ENGNG., 8 Dec., p. 757) is one of three being built in this country in quest of the prize of £5,000 offered by Mr. Henry Kremer for the first unassisted flight of one mile by a man-powered aircraft. Considerable athletic ability will obviously be needed to pedal-cycle the Southampton entry into the air for this distance. If anyone can achieve this feat then Mr. Elliott, a pilot with the Cambridge University Air Squadron, would seem to be made for the job.

Special Article

Power-Full India Elects Coal and Water

Future industrial expansion in India turns from the widespread inefficient use of wood and waste materials with a new appreciation of the country's natural resources and the scope for nuclear and oil power.

THE demand for energy in India is growing rapidly due to industrialization, increasing transport facilities and rising standards of living, but consumption per head is still among the lowest in the world and amounted to 0·4 tons of coal equivalent in 1960. According to an estimate prepared in the perspective division of the Indian Government's Planning Commission, total production of energy in 1960 was roughly of the order of 172 million tons of coal equivalent (*mtce*), made up as shown in Table I.

Nearly 60 per cent of the energy is derived at present from non-commercial sources such as cattle dung, wood, charcoal, agricultural wastes, etc., cattle dung itself constituting nearly half of the total non-commercial energy. Dried cattle dung is the main source of heat for cooking and heating throughout the rural area and in many urban households as well, and roughly 1,200 tons of dung were used for this purpose last year. The fuel-wood consumption is estimated to be of the order of 60 million tons and this does not include agricultural wastes like bagasse which account for nearly 20 per cent of the non-commercial block. The present pattern of energy consumption thus has a preponderance of the non-commercial energy element, which makes for extremely inefficient use of the overall energy resources; but in the absence of commercial substitutes, this is considered inevitable.

FUTURE PATTERN

How will the future affect this pattern? Planning in India is proceeding on the basis that the economy will grow at an average rate of about 5 per cent annually, the rate of growth in mining, industry and transportation being almost double this figure. On this basis, a detailed study of the country's energy requirements has been undertaken by a research institution in New Delhi which has recently brought out a monograph indicating the trend of growth of different types of energy anticipated over the next 15 years. The study is by no means conclusive but it does point up to a tremendous " explosion " in the energy situation, the total requirements rising from about 70 *mtce* (of commercial energy) in 1960 to over 300 *mtce* by 1975, a fourfold increase in 15 years (Table II). Apart from this purely quantitative change, the energy spectrum is expected to undergo a major change. The proportion of non-commercial energy, for instance, will go down sharply from the current 60 per cent to slightly over 20 per cent of the total energy consumption, although in absolute terms, the volume will just barely drop to 88·0 *mtce* from the current 100 *mtce*.

TABLE I.—*Consumption of Energy in 1960*

Source of energy	Consumption (mtce)	Per cent of total
Coal	54·6	31·7
Hydro	7·9	4·6
Petroleum	9·5	5·5
Total—commercial	72·0	41·8
Cattle dung	46·0	26·7
Fuel wood	35·0	20·5
Agricultural wastes	19·0	11·0
Total—non-commercial	100·0	58·2
TOTAL ENERGY	172·0	100·0

Source: Perspective Division, Planning Commission, Govt. of India

Within the commercial energy block, the share of coal is expected to fall to about 71 per cent from 82 per cent in 1950 and 76 per cent in 1960. This is, of course, in accord with the general world-wide trend against coal that has been in evidence since the Second World War. A characteristic aspect of the changing energy pattern in India, however, is that the fall in the coal component is being taken up largely by hydro-power instead of petroleum. This is understandable, as the main emphasis during the next few plans is expected to be on the development of energy-intensive capital goods industries like steel, aluminium, cement, etc., which have a close correlation with coal and hydro-power.

Reserves of both coal and hydro-power in India are estimated to be sufficiently large to sustain their development well into the next century, and from the point of view of costs also, the two sources of energy are relatively cheaper than the rest. Another interesting fact emerging from the study is the estimate that " the Indian energy economy in 1975 will be substantially a coal-based economy, and even by AD 2000 it may have as high a proportion of coal as 55 to 60 per cent."

THE NEXT FIVE YEARS

The projections are very close to the Government's thinking on the subject, and the Third Five Year Plan, announced recently, lists targets which have been virtually lifted from the study (Table III). The energy programme is being geared to the attainment of these targets which have been by and large accepted by all concerned. Certain aspects of the programme, particularly those relating to nuclear power and petroleum development, have become rather controversial, for reasons which may be political rather than economic or technical, but which deserve consideration nonetheless. The " nuclear " controversy is almost settled and, on the eve of the opening of international tenders for the proposed Tarapore atomic power station, the broad aspects of the policy as enunciated by the Atomic Energy Commission have more or less received universal endorsement. The " petroleum " controversy is, however, still raging and bids fair to be as " explosive " as the growth in energy demand over the next decade.

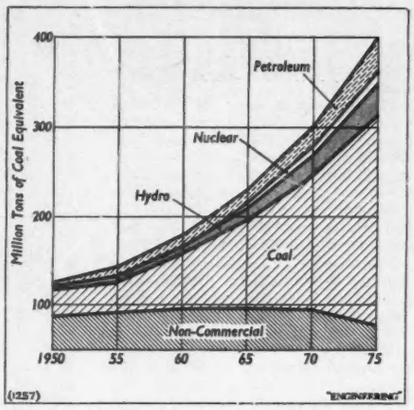
The background to the nuclear development in India is briefly that, although coal reserves are theoretically plentiful, they are localized in a few areas in the east and much of the reserves are of poor quality. Coal, therefore, has to be transported over long distances to the south and the eastern seaboard, which makes the total

TABLE II.—*Gross* Demand for Energy, 1960-1975 (mtce)*

Year	Coal	Hydro	Petroleum	Nuclear	Total commercial
1960	62·40	8·65	10·63	—	81·68
1965	97·13	15·50	16·99	0·95	130·57
1970	149·77	26·00	27·29	3·22	206·28
1975	227·36	40·20	44·21	7·52	319·29

* Including energy consumed in transporting and processing energy. Source: *Demand for Energy in India*, 1960-75, National Council of Applied Economic Research, New Delhi, 1960.

capital cost of thermal power stations almost equal to that of nuclear plants. Some of these areas can be fed by hydroelectric installations, but the capital cost of hydro stations in India can sometimes exceed that of nuclear stations although the unit cost of hydroelectricity is certainly lower than that from either steam or nuclear power plants. There are regions remote from the coalfields, such as Madras in the south and Kathiawar in the west, where " threshold conditions for the entry of nuclear power " are slowly taking shape, and Dr. H. J. Bhabha feels that it is essential for India to go ahead immediately with a plan of at least a million kW within



Energy in India, 1950-1975

the next seven years. Dr. Bhabha's programme has now been accepted by the Government and provision has been made in the Plan for a nuclear station with an ultimate capacity of 300 MW by 1965. Tenders for this station, which is to be located at Tarapore, a hundred miles north of Bombay, have already been invited.

In regard to petroleum, the position is slightly different. India consumed about 7 million tons of petroleum products last year and only half a million tons were produced locally from indigenous sources, the rest being refined locally from imported crude by foreign oil companies. The Indian oil ministry has an oil exploration programme of its own, conducted with the technical and financial collaboration of Soviet Russia and Rumania, and the ministry has been successful in locating oil deposits in the Cambay-

TABLE III.—*Programme of Development in the Third Plan, 1960-1965*

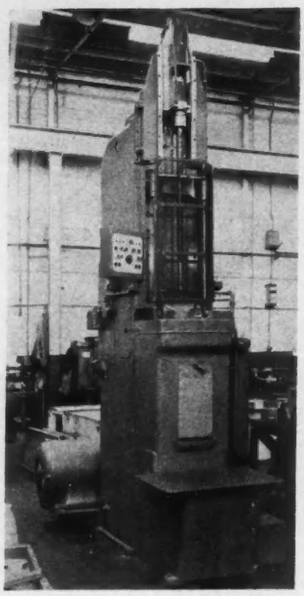
	Production in 1960 (× 10⁶)	Target for 1965 (× 10⁶)
Coal	60 tons	97 tons
Electric power:		
Hydro	1·93 kW	5·10 kW
Steam	3·46 kW	7·08 kW
Oil	0·31 kW	0·36 kW
Nuclear	—	0·15 kW
TOTAL	5·70 kW	12·69 kW
Petroleum :		
Refining capacity	6·0 tons	11·0 tons
Crude production	0·5 tons	4·75 tons

Source: Third five year plan, Planning Commission, 1961.

Ankleshwar area in Gujerat (north of Bombay, on the western seaboard) and also in Assam. Encouraged by these successes in a field normally unresponsive to newcomers, the Government has decided to take the entire petroleum development and refining programme under its own wing, virtually shutting out the foreign oil companies from any large-scale participation, except in collaboration with the Government under terms which are not considered favourable by them. The Government's programme over the next five years includes a refinery each at Gauhati (0·75 million tons of crude per year), Barauni (2·0 million tons) and Koili in Gujerat (2·0 million tons), all with the help of east European countries, including Soviet Russia. In addition, the programme envisages a number of product pipelines connecting the major consuming cities with the refineries, as well as exploration in new areas with the help of, among others, ENI of Italy and the French Petroleum Institute. Although requirements of petroleum products are expected to double in five years, the capacity of existing refineries is to be pegged at the present level unless the Government decrees otherwise.

BROACHING MACHINE

Operated Hydraulically



THE Model TR-15-48 hydraulic broaching machine illustrated, is now built in Britain under licence from the American Broach and Machine Company.

This machine, while intended for hand loading, is said to be easily converted to a fully automatic unit for transfer line operation. The machine has an electro-hydraulically controlled semi-automatic cycle. Manual advancement of the retractable table to the broaching position initiates the machine cycle. The ram stops automatically at the end of its downstroke, at which stage the table is retracted by the operator, the broached components being replaced with blanks. Table retraction triggers the circuit for the upstroke of the ram; when this is completed and the retriever has carried the broach to the top the operator advances the table for the next cycle.

Normal capacity is 15 tons. Maximum length of stroke is 48 in. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London NW2.*

WOBBLE SWITCH

Selects Four Positions

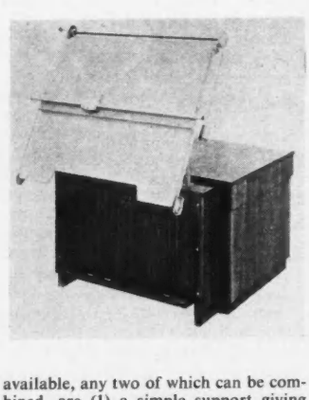
NOW being imported from Italy, two types of wobble switch are included in the range of Cema equipment available in Britain.

The two forms vary in that one, when the lever is released, returns to neutral, whereas in the case of the other type it remains in the position selected until such time as it is moved by the operator. Both switches—or selectors as they are also termed—consist of a double contact block, a nylon actuator, and a short selector lever. Movement of this lever, either vertically or horizontally, enables any one of four positions to be chosen; the central position is neutral. The switches are reported to be oil tight and to comply with the requirements of CSA No. 16661.

Normal current rating is as follows: figures in parenthesis are the inrush amperage. Alternating current, 110V 6A (60), 220V 4A (35), 380V 2·5A (20), 550V 1·5A (15). Direct current, 115V 2·5A, 220V 1A, 550V 0·2A. Dimensions are 5·6 in high; maximum width 1·6 in. A two-position selector is available. *Shawford Control Gear Company Limited, Victoria Road, London NW10.*

DRAWING AND REFERENCE UNIT

Balanced Board



THE Chalfont table combined drawing and reference unit combines a drawing stand with a back reference table.

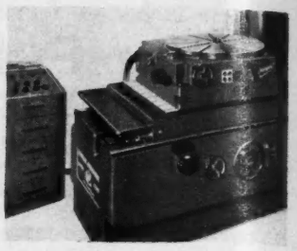
Unit construction is said to allow greater flexibility in planning drawing office layouts, and to provide the draughtsman with the arrangement of drawer and cupboard space best suited to his particular requirements. The drawing stand, bolted to the back of the table, houses the height adjustment mechanism, controlled by pedal. It is said to be freely adjustable. Constant tension springs eliminate balance weights. Quadrants with friction discs and torsion springs control angular adjustment. The stand is suitable for double elephant, antiquarian and hamburg drawing boards, with Eclipse parallel motion fittings, Alliance straightedge drafting machine, or parallelogram drafting machine.

The reference table, containing a full-length drawer, is double elephant or antiquarian size. Types of pedestal available, any two of which can be combined, are (1) a simple support giving maximum knee room, (2) a pedestal with two pull-out drawers and a pull-out tray, and (3) a pedestal with cupboard and shelf. A spacer unit can be used to join two or more tables for series layouts.

Angular adjustment is from the horizontal to 85°. Height adjustment is 12½ in. The table height is 30 in. *Hall Harding Limited, Stourton House, Dacre Street, London SW1.*

ROTARY TABLE

Numerically Controlled



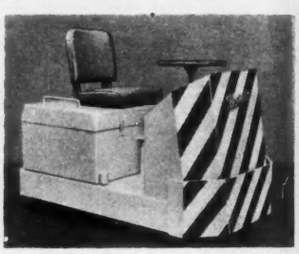
THE Rotoptic-6CN rotary table is a numerically-controlled dividing table with a diameter of 31½ in and a positional accuracy at any point in the circle of ± 2 sec.

The dividing table has been derived from the Rotoptic-6 table and embodies numerical control by punched tape or manual input. It is understood that the possibility of fitting this method of control to existing tables of the type mentioned is under consideration. When control by punched tape is employed, either 5 or 8 channel paper tape may be used. The platen positions are translated into the tape and fed to the table from the Emicon control console. When manual input is used, the prescribed degrees, minutes and seconds of arc are registered beforehand by using the appropriate buttons on the control panel. The control equipment is provided with a parity checking device, which automatically ensures the correct dimensions are read from the tape. The accuracy of the automatic indexing may be verified in the microscope of the optical measuring system. This enables fine setting of the platen to be made by centring the image of the built-in master circle appearing in the ocular field of the microscope within the double line of the reticle.

The table may be used as an individual unit or in conjunction with machine tools, the equipment being integrated with the numerical control systems. A load up to 2,200 lb is said to be supported without loss of accuracy, and special circumstances up to 3,300 lb. *EMI Electronics Limited, Hayes, Middlesex,* and *Société Genevoise Limited, Newport Pagnell, Buckinghamshire.*

ELECTRIC TRUCK

Capable of Towing 3 tons



KNOWN as the Floataire 1H tractor, the latest addition to the range marketed under that name is said to be able to tow 3 tons on the level.

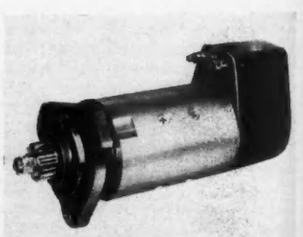
The new tractor, which is constructed from electrically welded steel plate, is a three-wheeled unit, the single driving wheel at the front being also the steered wheel. The steering lock is a full 180°. The driving component, housed in a malleable casting, is powered by a 24V series wound reversible CAV motor of 1 hp. Transmission from motor to roadwheel is through constant-mesh gears. There are three speeds in both forward and reverse; operation is by pedal. Control is said to give an easy inching motion. Top speed is 4·6 mph. Lockheed hydraulic brakes act on the rear wheels, there is also an independent hand brake.

Power is derived from a 12 cell Kathanode battery which can be supplied with a capacity up to 429 Ah, sufficient for 8 hours continuous operation on one charge. Battery removal is reported to be quickly accomplished. The whole of the power equipment is housed below the chassis, giving uninterrupted floor space. Control gear, manufactured by Expert Industrial Controls, is behind the dash panel and is accessible by removing four screws.

The wheels, of 10 in diameter, are carried on roller bearings. Solid Dunlop tyres are bonded to the press-on steel rims. Length of the tractor is 64 in., width 32 in., and height 41½ in. The draw pull is 220 lb. Weight complete with battery is 960 lb, and without 670 lb. The driving position is said to be particularly comfortable. *Floataire Limited, Joseph Street, Leicester.*

STARTER FOR DIESEL ENGINES

Reduces Weight



THE CAV Type SL5 electric starter is an axial unit of 5 in diameter, which is offered for road, rail, marine, and industrial applications.

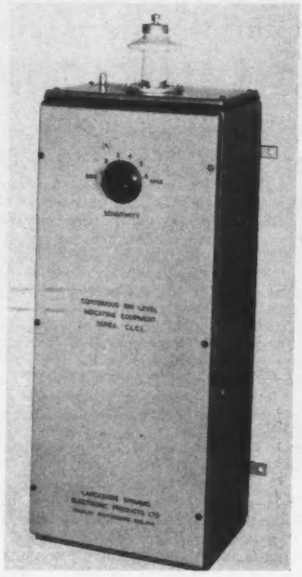
It is claimed that the starter is capable of doing the same work as most 6 in starters. In addition to saving space this enables weight to be reduced, the saving compared with the CAV Type U6 6 in diameter unit being 17 lb. Net weight of the SL5 is 43 lb. A spring-loaded multiplate clutch provides a safeguard against the engine backfiring or an excessive starter overload. Holding-on windings are incorporated to prevent the risk of the pinion being prematurely ejected, due to spasmodic firing before the engine is running normally. Direction of rotation is clockwise but anti-clock rotation can be supplied. SAE3 flange mounting for left or right hand mounting is available, cradle type mounting is also offered.

While bronze pinions of standard or stub tooth form are normally provided, hardened steel pinions for working with a hardened gear ring may be obtained as an extra. Two SL5 starters can be used for dual operation on a common gear ring. In such a case internal connections are modified and an additional solenoid switch fitted; this synchronizes the two starters and ensures that both pinions are engaged before either starter develops its full torque.

Voltage is 24; wiring is insulated return. The number of poles and the number of brushes is four in each instance. Terminals are of the post type. The nominal bhp is 6. Overall length of the starter is 15 in, plus 1 in outboard movement when engaged. *CAV Limited, Acton, London W3.*

LEVEL INDICATOR

Measures Hydroscopic Solids



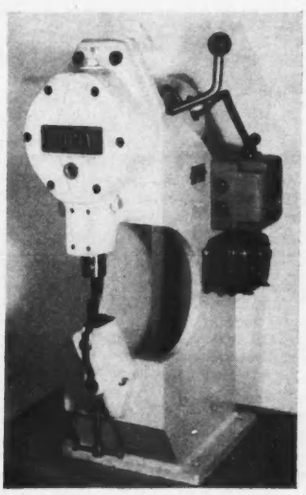
OPERATING on the change in electrical capacitance as material builds up along the length of an electrode, Quantimeter indicating equipment gives continuous indication of levels of liquids or free-flowing solid materials in bulk storage containers.

Claimed as a feature is the inherent compensation against indicational errors resulting from variations in the moisture content of materials. It is said that this compensatory arrangement ensures that readings are reliable, even when dealing with hydroscopic solids.

The capacitance range is adjustable in six stages, 100, 200, 400, 800, 1,600, and 3,200 mmfd. These have been selected to meet requirements for most materials and a wide variety of container sizes. Distance between the indicator and the main control unit may be as much as 1,000 yards. Maximum operating ambient temperature is 45° C. Linearity of indication is said to be within ±2·5 per cent. *Lancashire Dynamo Electronic Products Limited, Rugeley, Staffordshire.*

SHEET METAL WORKING MACHINE

For Bench Mounting



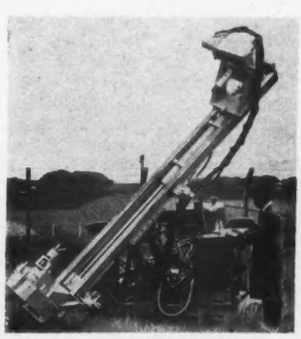
LATEST addition to the Pullmax sheet metal working machines is the Type P1S, for sole plate production and similar operations.

This machine is claimed to have numerous applications where greater ease and economy in the freehand cutting of irregular shapes from sheet are required. Consisting basically of a P1 type workhead mounted in a frame with a short throat, the unit is compact and comparatively light, lending itself to bench mounting. Alternatively, machines may be mounted on a single beam, allowing the operator to move through 180°. Either method of mounting allows cutting at any position inside the edge of the plate.

When the maximum tensile strength of the material is 25 tons per sq. in, the maximum thickness of the plate which can be edge cut is $\frac{1}{4}$ in. Greatest thickness of plate which can be cut in the centre or without a starting hole is 12g. Cutting speed is 17 ft per min. Stroke length is $\frac{3}{16}$ in. Overall length is 16 in and height 22 in. The machine can be supplied for nibbling. *Alfred Herbert Limited, Edgwick Works, Coventry.*

ROTARY AND THRUST DRILL

Crawler Mounted



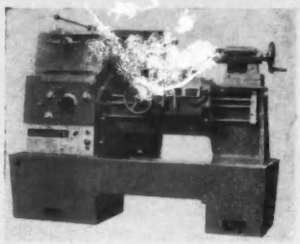
THE Consolidated C155 Reichdrill crawler mounted self-propelled drilling rig illustrated has been introduced for general blast hole work, deep drilling for grouting or for anchorage in hard rock, prospecting in alluvium and for well boring when used in conjunction with a 6 in diameter casing.

The drill is powered by a Ford Dexta three-cylinder diesel engine giving 25 hp at 1,450 rpm. Alternatively, a Sutton Power Pack may be fitted. The output from the engine is to a Triple Deri-Syne hydraulic pump through a Renold chain coupling, to give a system pressure of 1,750 lb per sq. in for operating the mast-positioning cylinders, drill rotation motor and self-propelling mechanism. A towed CP 365-RO-2 rotary Power Vane compressor provides air power for the in-the-hole hammer and for air flushing.

The drill frame is carried on two Bristol crawler tracks which have 10 in pads at 5 ft centres, the overall length of the tracks being 8 ft 3 in. A mast carrier bracket is welded to the leading end of the drill frame, this bracket carrying a swivel plate in which the drilling mast is held. This swivel plate, operated by a double-acting hydraulic cylinder, swings the mast through a maximum of 160°. Carried through the bracket is a second ram which raises the mast from the retracted travelling position. The drill has an effective working stroke of 11 ft. *Consolidated Pneumatic Tool Company Limited, 232 Dawes Road, London SW6.*

HIGH SPEED LATHES

Geared Headstocks



JUST introduced, the Elliott M Series of high speed lathes is available with centre heights of 7½ and 8 in, and lengths between centres of 24, 36, 48, and 60 in.

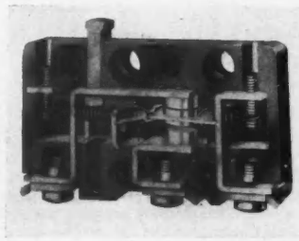
A feature of these lathes is the Omnispeed drive. The geared headstocks offer speed ranges of 30 to 2,500 rpm, or 20 to 1,650 rpm. The drive is transmitted to the headstock by timing belts in the case of the four speeds from 720 to 2,500 rpm, and by gears in the case of the eight speeds between 30 and 525 rpm. It is claimed that even when the spindle is running at 2,500 rpm the maximum gear meshing speed is below 700 ft per min. A foot brake operates on the input pulley. The spindle bore has a diameter of $2\frac{1}{16}$ in. Temperature rise is claimed to be limited by oil cooling of the front spindle bearings from a bearing spacer cooling jacket. A DIN6 flanged spindle and quick-change swash-plate is fitted.

The totally enclosed dial change feed box provides all standard threads from 1½ to 80 tpi (including 13 and 19 tpi) direct in 45 changes and from 0·1875 to 10 mm in 24 changes. To prevent over speeding of the feed box an automatic 4 : 1 reduction is provided for use when the four highest spindle speeds are engaged. The switchgear, consisting of a no-volt release, mechanically interlocked reversing contactors and overload protection, is in a watertight box.

Swing over cross slide is 9½ in and 10½ in respectively in the two sizes. Swing in the gap is 20⅝ and 21⅛. Faceplate diameter is 12½ in. Headstock taper is shortened B. and S. No. 14. A wide range of equipment is available. *B. Elliott (Machinery) Limited, Victoria Road, London NW10.*

DOUBLE ACTION MICRO-SWITCH

Acts Rapidly



THE MS10 double-action micro-switch has been developed to ensure rapid contact separation.

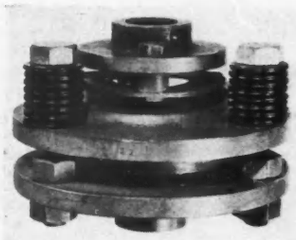
Claimed to be suited for arduous duty as a limit, control, and safety switch, it is said that any unstable condition is limited to a detached actuating fork and is not transmitted to the contacts. It is said that this switch offers for the first time the possibility of transforming a very slow actuating movement into a snap-action switching operation. Snap action of the actuating fork is initiated by the operating plunger, the fork then changes its position rapidly, knocking on to the contact carrier which snaps over to the opposite contact.

It is stated that the switch has a wide field of application, and that all actuating movements can be utilized, some with the aid of special attachments. The contact arrangement is single-pole, double-throw (change-over). Rated voltage is 440V ac or 250V dc. Rated current (continuous) is 10A. Maximum make current is 20A at 440V ac or 250V dc, or 30A at 240V ac or 110V dc. Maximum break current is 6A at 440V ac or 10A at 240V ac, both resistive load. Average mechanical life is stated to be 10,000,000 operations, and maximum operating speed 3,000 operations per hour. Travel for actuating the element is 0·03 to 0·04 in. Operating pressure is approximately 9 oz and release pressure approximately 1 oz.

A large range of accessories and enclosures is available which enable the device to be widely incorporated. Temperature, pressure, door and machine guide control are among the suggested safety switch applications. *Chilton Electric Products Limited, Hungerford, Berkshire.*

OVERLOAD CLUTCH

Modified to Increase Capacity



ORIGINALLY developed as a safety device for use on motor driven variable transformers for unattended automatic voltage regulation, the Metastream overload slipping clutch has been modified.

The modification consists of the inclusion of Belleville washers, which alteration has resulted in the capacity being increased. The washers may be placed in parallel or arranged in series, the layout being determined by the slipping torques required for particular applications.

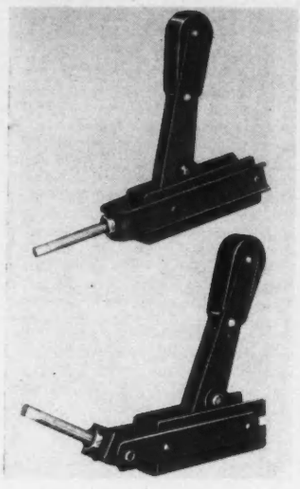
Constructed from close grained cast iron, the clutch is cadmium plated except for the area which is covered by the friction discs. A Metastream flexible coupling, in either single or double bank form, is incorporated to accommodate malalignment and differences in the shaft end distances which could otherwise sensibly affect the pressure on the friction plates. Limited clearance between the input hub and the enclosing plate accommodates slight malalignment. It is also possible, if necessary, to incorporate a slotted hub and pin through the driven shaft to provide for installation variation in the distance between shaft ends.

Overall the unit has a diameter of 3½ in, and a length (including coupling) of 2½ in. The weight of the whole is 2¼ lb. Slipping range is variable from 0 to 110 lb-in. Normally the units are supplied pilot bored, but boring and keywaying is undertaken as an extra.

These clutches may be employed to safeguard motors in the event of the failure of limit switches. *Metaducts Limited, Catherine Wheel Road, Brentford, Middlesex.*

CLAMPS

Movement Control Throughout Stroke



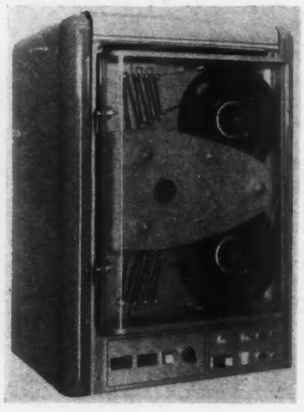
UNDER the trade name Powertog two new clamps have been introduced. That in the top illustration has a push action and is known as Model ST609; the lower unit is styled ST612 and has a pull action. Both are shown in the open position.

It is claimed for these clamps that the movement of the ram is controlled throughout the stroke, and that while these two models are constructed to move in a straight line the linkage and guiding slots are adaptable to cover a range of simple and eccentric movements. Both models when closed with the handle down have an overall height of 2½ in. In the case of the Model ST612 a swivel bracket is provided for the spindle seating so that variation in alignment between different workpieces can be taken up. The standard plain spindle can be modified and fitted with an adaptor to suit a variety of applications, among which is the holding down of the lids of chemical vats.

Both the model ST609 and ST612 clamps have a stroke of ½ in. *Speed Tools Limited, Vereker House, Gresse Street, London W1.*

DIGITAL TAPE UNIT

Alternative Mounting



ORIGINATING in France, and now available in Britain, the Pen 3 digital tape unit is claimed to be suitable for computers, off line data processing instrumentation, and industrial control applications.

It is reported that the equipment has been produced to meet a demand for a reasonably priced medium performance magnetic tape unit. It can be supplied as a deck and control one for mounting in customers' racks, or alternatively is self contained complete with fully transistorized read and write electronics. The Pen 3 is claimed to be particularly suited to applications requiring consistent performance for long periods, and where rapid access to a large quantity of digital data is essential.

The tape capacity is 2,400 ft, using 10½ in NARB spools. Tape widths are ¼ in or 1 in. Tracks are 8 or 16. Tape speeds, selected by switch, are 60 and 30 in per sec or 30 and 15 in per sec. Start/stop times are said to be less than 5 millisecs. Packing density is stated to be 250 bits/in. The magnetic heads have a double gap spaced 0·39 in apart. Controls are automatic or manual. The unit is suitable for mounting in a 19 in rack. Power requirements are 127V ± 7 per cent single phase 50 or 60 c/s ac. *Epsylon Industries Limited, Feltham, Middlesex.*

PIPE CONNECTOR

Withstands Pressure and Temperature

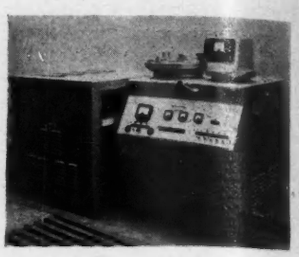
RUSTON-GRAYLOC clamp connections are available in a range to match standard pipe sizes from 1 to 30 in, and are made to suit varying pipe thicknesses for each nominal pipe size. In the sizes suitable for ¼ to 1½ in bore pipes, a screwed union connection on the same sealing principle may be used in place of the bolted clamp connections.

Compared with an orthodox flange connection, the Ruston-Grayloc joint is claimed to be able to withstand higher pressures and temperatures, to be easier to assemble, and to offer reductions in weight and space. Hubs are available for pipes prepared for butt weld and socket weld connections throughout the size range; hubs for pipes with threaded connections can be supplied up to 8 in pipe size. The sealing procedure is said to be readily adaptable to other containment problems, where extreme tightness is essential, for example closures, vessels, and connections in hydraulic, steam, and gas systems; it is reported to be suited both to pressure and vacuum.

The seal member consists of a steel rib with a flexible taper lip on each side. When the hubs are pulled together the seal lips mate with the hub seats and a line seat is formed which changes to a surface seal as the lips deflect within the elastic limit. Any internal pressure intensifies the sealing action. It is reported that Ruston-Grayloc sealing members can be re-used many times while remaining leak proof. *Ruston and Hornsby Limited, Ruston Paxman Sales Division, Lincoln.*

FURNACE

For Sintering or Heat Treatment



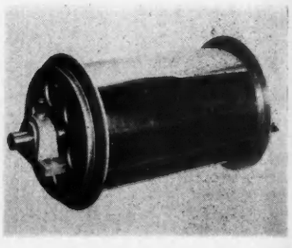
TWO versions are available of the VMD high vacuum sintering or heat treatment furnace recently introduced. One is controlled manually and the other embodies semi-automatic controls.

Claimed to have the simplest possible operating cycle, the manually controlled unit, illustrated, has the charge loaded on a tiered tray assembly. Operating temperature is reported to be as high as 2,400°C at pressures better than 10^{-5}mm/Hg. Fabricated from tantalum or tungsten sheet, the segments of the heating element form a circle of 3¾ in diameter, the length of the element being 15 in. It is enclosed by radiation shields made from tantalum sheet, the use of refractories being dispensed with. The element and shield are stated to be readily detached from the chamber in which they are housed within the steel cabinet. Transformers, located in the second cabinet feed the heating element, variation being provided by an auto transformer controlled by a rotary switch or core reactor system. Independent fuses are provided for each main component and safety interlocks are fitted to give protection against water failure.

The semi-automatically controlled unit is of the same general design as that described above. A multi-position rotary switch ensures correct sequence; each position is clearly marked and overriding switches enable any individual operation to be carried out without the use of the sequence switch. The heating control can, we are informed, be slaved to the pressure instrumentation. *Vacuum Metallurgical Developments Limited, Alma Works, Levenshulme, Manchester 19.*

MAGNETIC DRUM SEPARATORS

Many Sizes Available



UNIMAG permanent magnetic, non-electric drum separators have been introduced for the automatic extraction of tramp iron or iron contamination. They are said to be applicable to a wide range of products, such as foodstuffs, plastics, paper stock, textiles, foundry sand, and the like.

The drum embodies continuous pole-magnet units for general iron contamination extraction problems, or alternate pole-magnet units for use where it is necessary to gyrate the material in order to disentangle the ferrous portion from the non-ferrous. Available in diameters from 9 to 42 in, and widths of from 6 in to 8 ft, the units are reported to be suitable for inclusion in plants or self-contained magnetic separators which are fed by controlled gravity or vibratory chutes. They may also be built into conveyor belts as the head drum.

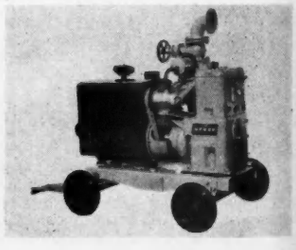
Magnet units are constructed from anisotropic permanent magnet alloy, or from anisotropic ceramic magnet material. They are mounted on carriers which are fitted to the shaft. Fixed mounting blocks at the ends of the shaft hold the magnet stationary, the drum shell revolving around it. The shell, of brass or stainless steel, runs on sealed ball bearings.

All ferrous pieces are retained against the drum face and rotate with it to the bottom, where the magnetic field terminates. At this position ferrous parts fall from the drum and are discharged into a container or into trunking.

It is understood that these separators are normally supplied to customers' requirements. *Industrial Magnets Limited, 28 Station Road, Acocks Green, Birmingham 27.*

CENTRIFUGAL PUMP

Self-Priming



KNOWN as the Univac UVS4, the Sykes 4 in self-priming centrifugal pump is reported to be unchokeable and to have an output of 27,900 gph with a 10 ft lift against a nominal head.

In addition to handling free flowing slurries and abrasive sludges of up to 60 per cent solids content, the pump is reported to be able to cope with solids of up to 2½ in diameter. The time occupied in priming is said to be 13 sec at 10 ft lift, and 58 sec at 28 ft; at the last-mentioned lift output is 7,200 gph. By separating the self priming and pumping duties, cavitation effects are stated to have been reduced to a minimum, enabling high outputs to be obtained on long lifts with suction lengths of up to 500 ft. Priming is carried out by a 22 cu. ft per min rotary vacuum pump.

Power is supplied by a Lister SL3 air-cooled three-cylinder diesel engine developing 12·75 bhp at 1,800 rpm and 10·8 bhp at 1,500 rpm. Fuel is supplied by a lift pump from a tank having a capacity of 13 gallons, formed in the chassis. This supply is sufficient for 24 hours continuous operation under normal running conditions. The CAV fuel pump and injector are totally enclosed. The pump packing gland is externally sealed by grease-impregnated packing. The impeller, which has three blades, is of nodular cast iron. To prevent electronic action the pump wearing plates and casing are of grey cast iron; the pump is stated to be able to pump sea water without deterioration. When dealing with liquids which corrode cast iron, components are available in suitable materials. *Henry Sykes Limited, 53b Southwark Street, London SE1.*

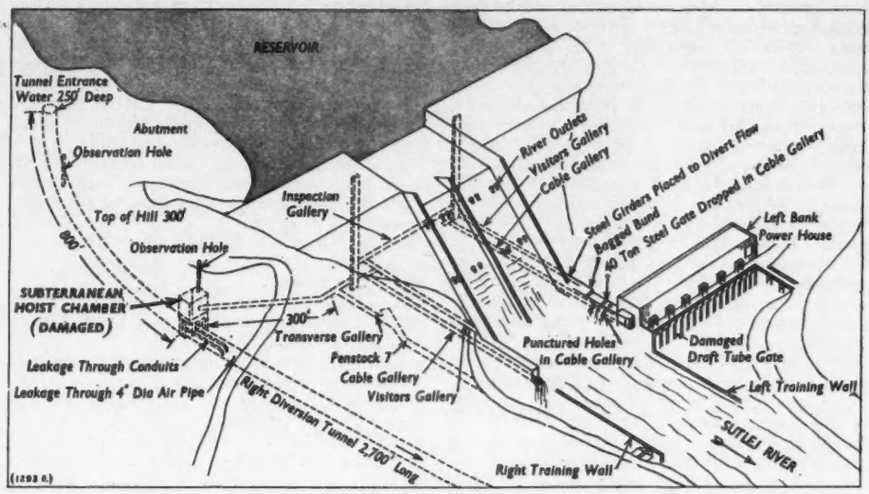
Bhakra Dam Mishap and Repair Works

During construction of the Bhakra dam in the Punjab, one of the diversion tunnels burst. The galleries and power house were flooded. Model tests were used to evaluate the proposed remedial works.

BHAKRA dam across the Sutlej river in the Punjab, will be one of the highest gravity dams in the world. It will be 740 ft high and will back up as much as 8 million acre-ft of water for irrigation and power generation. During the course of its construction, a serious mishap took place which, but for the timely and ingenious action on the part of the engineers, would have greatly delayed the date of completion.

In the early stages of construction the Sutlej river was diverted through two 50 ft diameter concrete-lined tunnels, each half a mile long on either side of the gorge. The left tunnel was subsequently plugged with concrete. The flow through the right diversion tunnel was controlled by two hydraulically operated regulating gates and two emergency gates. These gates, weighing 73·7 tons each, were operated from a hoist chamber niched in the right abutment of the Bhakra dam above the diversion tunnel, but nearly 300 ft behind the rock face. It is connected with the main dam through an adit tunnel. The function of the chamber was only to control the release of the water from the Gobindsagar (the reservoir) during the construction period of about two years. It had been scheduled to be plugged in October, 1959.

On 21 August, 1959, the Gobindsagar contained water 300 ft deep behind the dam—234 ft above the level of the floor of the hoist chamber. The control gates below the hoist chamber were partially open. At approximately 2 pm a slight separation was noticed between the junction of one of the two columns supporting the hoisting mechanism and of the floor of the chamber. Water began to ooze through a hair crack near the adit tunnel mouth and the flow continued to increase until it became a small fountain. Suspecting an extraordinary strain on the columns and consequent failure, which would end up in water flooding the hoist chamber and thence the dam galleries and the power house, the engineers ordered all four gates to be completely lowered into the diversion tunnel below, relieving the strain on the columns. Even so, at about 6 pm the floor ruptured and water exploded into the hoist chamber.



Layout of the hoist chamber, galleries and power house of the Bhakra dam.

From there the water rushed into the adit tunnel, through the visitors' and cable galleries and finally found its way into the left bank power house at the other end of the dam. It soon partly submerged the generators under construction.

The two pressing problems before the engineers were (*a*) to stop the flood of water through the hoist chamber to the power house; and (*b*) dewatering of the power house. The flood flow from the hoist chamber could only be stopped by sealing off the diversion tunnel below it. This problem was examined on scale models in the Punjab Research Station and it was found that the tunnel could be plugged by dropping precast blocks of plastic cement concrete into the mouth.

A phased plan was drawn up for stopping the flood flow into the power house. The cable gallery was punctured in two places, allowing part of the flow to be diverted directly to the spillway before its entry into the power house. Next a 40 ton emergency gate was lowered between the power house and the punctured holes in the entry to the power house. The small leakage of about 35 cu. ft per second from the cable gallery past the gate towards the power house was pumped out.

Water was still shooting into the power house from the visitors' gallery and there was also a back flow from the river from one of the damaged draft tube openings of the power house. The shoot from the gallery was completely diverted into the spillway by a barrier of girders. One of the draft tube gates which had failed was salvaged by Indian Navy divers, repaired and put back into position two months later, on 20 October. Flooding having been stopped, water in the power house was pumped out by 25 October.

Closure of the diversion tunnel was tackled in stages. The first phase aimed at choking the mouth of the tunnel at the bottom of the reservoir by dumping plastic concrete crates, precast concrete blocks, aggregate, sand, pozzalana bags and so on. Secondly, access to the flooded hoist chamber was obtained by driving an approach tunnel to the top of the hoist chamber from a nearby existing railway tunnel. At the same time access was sought to the hoist chamber by driving a second tunnel from further along the railway tunnel. Plugs were put into the diversion tunnel through both these points of access.

The tunnel blocking operations in Gobindsagar were actively undertaken jointly by Army and Bhakra engineers. Strings of barges went round in a circuit, loading concrete crates from the dam line and floating down to the site of the tunnel mouth and dumping their cargo into the water at calculated spots, so that the crates would sink to plug the mouth of the tunnel. The choking operations were started in October, 1959. By 25 January, 1960, the leakage was reduced from the original flow of about 10,000 cu. ft per sec to only 375 cu. ft per sec.

Over 36,000 cu. yd of concrete were dumped as crates, precast blocks and bags. Similarly, some 126,100 cu. ft of rock, 1,062,000 cu. ft of aggregate, 490,000 cu. ft of sand and 54,000 cu. ft of pozzolana bags and 14,040,000 cu. ft of clay were ultimately required to complete choking of the right diversion tunnel. To handle the residual leakage of 375 cu. ft per sec, six syphons of 2 ft diameter were installed in the hoist chamber, a remarkable feat of engineering.

A happy sequel to the Bhakra accident was the salvaging and reconditioning of the expensive electrical plant in the left bank power house, without sending them back to manufacturers.

Water swirling inside the stator of a partly erected generating set in the power house.

Swedish Building Methods and Materials

In a country such as Sweden that has a high timber production, it is not surprising that much of the construction is of wood. For example, 65 per cent of the one and two-family houses in Sweden are built in wood. However, with the recent advances in concrete and brick manufacture, the timber industry has lost some of its former position. Types of framework construction which are more economical in the use of wood have been increasingly adopted, leading to the present timber consumption of only approximately 2½ cu. ft per sq. m of floor space. The use of large factory made units for the walls has reduced the amount of on-site work and a better thermal insulation has been obtained than with the solid wood structures; in a cold country this is an important aspect of fuel economy.

More recently, there has been a tendency to move away from the use of small blocks of lightweight concrete, in favour of storey-high elements of the same material. This has led to the development of " sandwich " elements, consisting of lightweight concrete panels, 2½ m wide and of storey height, each 7 cm thick, joined by a layer of styrene 6 to 8·5 cm thick.

In another building, the original small size of concrete block has been preserved, but construction has been simplified. The staves are made with a tolerance of $\pm$ 0·2 mm, enabling the walls to be erected with only 1 mm thick glued joints or even with no bonding at all. In the latter case, the staves are joined by small plastic strips which are placed in specially cut jointing grooves. Recent tests indicate that walls joined in this way have nearly the same load bearing capacity as those with glued joints. This type of unbonded wall has been approved by the Swedish authorities.

A number of office buildings have recently been designed as complete steel structures and building work has now begun. In the centre of Stockholm five multi-storey buildings have been erected, the first four being built with a concrete frame, but the fifth, still under construction, has a framework of steel. Standard rolled steel joists are mainly used with a few machine-welded box structures for certain columns. The floor is made up of primary and secondary steel girders with intermediate concrete beams placed on the lower flanges of the steel girders. In the Wenner-Green Research Centre in Stockholm, the connections between the steel members have been made using high tensile bolts.

Plastering and other surface treatments normally given on the site have been simplified by factory techniques. A thinner plaster is used that is sprayed on to the material in a single layer. Smooth surfaces are painted with sand putty. It has been shown by experiment that the thickness of the plaster should generally not exceed 6 mm to secure adequate strength of adherence to the parent material.

Plastics have also begun to be used to a larger extent than in the past, primarily the acrylic plastics and glass fibre reinforced ester plastics. Swedish practice, however, has been to limit the use of plastics because of their combustibility; in particular, certain plastics give rise to very dense smoke when attacked by fire. They have, nevertheless, been widely employed for exterior decorations, such as balcony fronts.

Houses Built Throughout in Aerated Concrete

In Edinburgh two prototype houses have been built entirely of Siporex, a lightweight cellular building material recently introduced into Britain by Costain from Sweden.

The two houses are built throughout of the material—external and partition walls, floors and roofs being made with different forms of Siporex. Architect designed and approved by the City's Department of Health, the two houses are contained within a single block, one comprising a three-bedroom maisonette on two floors and the other a two-bedroom flat; both have living room, kitchen and other usual offices.

Siporex is made in 2 ft widths and in lengths up to 20 ft. It can be supplied in thicknesses varying by 1 in from 3 in up to 12 in. The standard building block in the material has face dimensions of 24 in by 8¾ in. The material is an aerated concrete comprising fine sand, Portland Cement, aluminium powder and some additives; when mixed as a slurry, hydrogen is liberated in sufficient quantities to give the material its many closed spherical cells that are its principal physical characteristic. After pouring into the moulds and initial hardening it is steam cured for 18 hours. It is available in both plain and reinforced forms.

In the Edinburgh houses, which have been designed on a 2 ft module, all the walls above the dampproof course up to the first floor level are in Siporex blocks, the external walls being 8 in thick and solid—replacing the 11 in brick cavity wall commonly used in this country. The partition walls are of 4 in thick blocks. The first floor is supported on the 8 in external walls and is constructed in 7 in thick reinforced units 2 ft wide, which span the full 18 ft width of the house. The upper external walls which, in turn, support the roof are constructed in 8 in thick storey-high reinforced slabs. The roof units are 7 in thick and reinforced.

Externally the treatment for all block work is a two-coat rendering, using Nobel Plastic Cement, finished with dry dash; the slab work is not rendered in this fashion but is finished with a spray coat of Sicrol U, a proprietary finish for the external surfaces of Siporex slabs. Internally, the block work is plastered with only one coat of Nobel dual lightweight plaster instead of the traditional three coats. The internal finish on the slab work is either a skim-coat of the same plaster or the surface is left untreated for painting or papering.

The roof units are laid to fall to concealed gutters and the three-layer bituminous felt roofing is bonded direct to the Siporex. The need to lay screeds to obtain necessary falls and to create insulation has been eliminated by the use of the slabs. Furthermore, no plaster finish is required on the underside, these surfaces being painted and the chamfered joints of the slab units being left to form a pleasing architectural feature to the ceiling.

As an aerated concrete Siporex possesses the basic structural and physical qualities of concrete and yet it can be worked and sawn like timber. This makes electrical installation very easy, for it is no longer necessary to cut chases in brickwork to conceal electrical conduits. A special tool cuts the channels in minutes. In addition door standards, windows, skirting and the like can be nailed directly to the walls, plugging and fixing of grounds being unnecessary.

In all other respects the houses follow the traditional manner of construction, but the finished product is claimed to be about three times better insulated than normal brick cavity construction.

Costain Concrete Company, Newmaines, Lanarkshire.

Air Conditioning Plant for Multi-Storey Building

A total of 38 Matthews and Yates Cyclone fans will provide the low velocity ventilation air for the Cooperative Insurance Society's new 25-storey skyscraper and the 14-storey Cooperative Wholesale Society building next door in Manchester. It is reported that the C.I.S. skyscraper, which stands 375 feet above street level, will be the tallest in Western Europe when it is completed.

Both buildings will be completely sealed and fully air-conditioned. Fourteen separate air-conditioning plants will be used and the total amount of air required will be approximately 650,000 cu. ft per min for the two buildings.

Heat is supplied by high pressure hot water from four Danks corner-tube boilers with a total capacity of 40 million Btu per hour at 350°F. Chilled water for air conditioning is provided by three 500 tons capacity Turbomaster packaged water cooling systems made by York Shipley Limited. Each comprises a York single-stage centrifugal compressor driven through a speed increasing gearbox by a Bruce Peebles motor, and is complete with shell and tube evaporator and condenser with copper Integron finned tubing. Capacity control is maintained by a York automatic control panel.

The problems of air distribution in multi-storey buildings are considerable, as ducting must usually be sited between the floor and the soffit of the beams. An extra 6 in on each floor of a 30-storey building can make a difference of 15 ft—or one complete floor. For this reason, the system chosen for the main air supply to the office spaces of both buildings was high pressure, high velocity air; thus permitting the use of quite small ducting.

The C.I.S. building consists of a central 25-storey tower with an adjacent 5-storey podium block. The main high velocity plant, consisting of two 65,000 cu. ft per min units, is installed in the podium on the roof of the fifth storey. Distribution is by a shaft which runs vertically through all floors. At ceiling level on each floor there are heater/cooler coils to control temperatures for each individual floor. This particular plant gives two air changes per hour and a common extraction shaft re-circulates 80 per cent of the fresh air supplied.

The secondary high velocity system for the C.I.S. building is for the tower block and is in two units, each of 25,000 cu. ft per min. One plant serves the ten lower floors and the other serves the ten upper ones.

The air capacity of the low velocity system totals approximately 162,000 cu. ft per min, part of which is fresh air and part recirculated. This air is circulated entirely by Matthews and Yates slow-speed multivane centrifugal fans. These systems serve such areas as the assembly hall, cafeteria, workshops, kitchens and stores, which are mostly located in the basements.

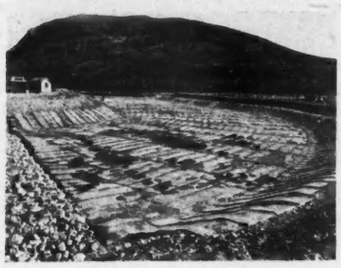
The internal zones of the tower are also conditioned by low velocity air. Small plants, again employing Matthews and Yates slow-speed fans, are situated on every floor. These plants extract the air supplied from the high velocity perimeter system, condition it and take it to the internal zone by means of high level trunking above the suspended ceiling. Light fitting diffusers are used for distribution. Final extraction of this inner zone air is by extraction fans fitted in the toilets.

Matthews and Yates Limited, Cyclone Works, Swinton, Manchester.

Erosion Protection on Spillway

After recent modifications to the existing weir at Loch Cuaich an over-flow channel has been excavated to prevent excessive water levels in the loch. The channel, which links up with the normal water course below the weir, was cut in soft peaty soil; to counteract rapid erosion, heavy duty protective " Famliner " sheets were used to line the channel.

Famliner sheets are ¼ in thick and filled with a bituminous core reinforced with stout wire mesh, both surfaces being filled with Fibreglass tissue. The Famliner was laid by the main contractors, Balfour Beatty Limited.



One end of the lined over-flow channel.

Prior to laying the sheets, the excavated surface was treated with weed killer and the sides and bed of the channel compacted. The sheets were mitred on site to conform to the line of the spillway and were anchored in an 18 in V-trench at the top of each bank by driving elm stakes (2 ft long) through alternate laps. The trenches were afterwards backfilled. Sealing between sheets was obtained with 6 in overlaps using hot-run R95/25 bitumen. The up and down-stream ends were locked into position by stone-filled gabions.

F.A. (Membranes) Limited, St. Helens, Lancs.

Durable Plastic Paint

A plastic paint has been developed that will produce a hard continuous surface resistant to acids and alkalis. " Pitaglaze " wall covering will give an unbroken tiled surface that can be washed or hosed down at frequent intervals without affecting the surface.

Four coats are required to be applied to smooth concrete and plaster, and the material cost is approximately 6*s* per sq. yd. It is supplied in pure white and varying shades and is particularly suitable for hospitals, schools, dairies.

Allweather Paints Limited, 36 Great Queen Street, London WC2.

House Removal in Exeter

Exeter City Council found that one of the new roads designed to relieve traffic congestion in the city involved the demolition of one of the oldest three-storey houses in Northern Europe. The architects, David Evelyn Nye and Partners, felt that it would be undesirable to demolish and reassemble the building, since, due to deterioration of the structure with age, reassembly would amount to a reconstruction.

The structure was therefore lifted off its present site to a prepared position 300 yards away. It was carried on a timber chassis which was supported at the corners by four pairs of iron wheels connected to hydraulic legs capable of extending to a maximum of 3 ft 6 in. The wheels were self-adjusting to fit any gradient of the ground (maximum slope: 1 in 10) and could be turned through 360°, so that the building always remained erect and could be moved in any direction. The wheels ran in steel channels for most of the distance and on steel plates when direction was being changed. Winches were anchored to the road opposite the two sites to move the house and also at the top of a hill.

The building was stiffened by continuing the timber framing of the chassis up within the building and by providing further cross-bracing. All the fixings were made by clamping and wedging to save puncturing the original timbers.

The removal was by Pynford Limited, 74 Lancaster Road, London N4, who specialize in foundation work, jacking and underpinning operations.

Road Compaction in West Africa

An AW/Albaret Autopactor pneumatic-tyred self-propelled soil compactor is being delivered to Costain (West Africa) Limited for building laterite roads in Northern Nigeria. The Autopactor is one of the range of compactors now being made by Armstrong Whitworth under licence from the Albaret company of Rantigny, Oise, France. It is a seven-wheeled machine weighing 15,500 lb unballasted and 33,000 lb ballasted.

These compactors have previously been successfully employed on the construction of stabilized-sand highways in France and other parts of Europe, and this experience suggested their suitability for use on the Nigerian contract. Costain have a £500,000 contract for the reconstruction of 63 miles of road between Zungeru and Bida, and another valued at £300,000 for the reconstruction of 57 miles between Katsina and Daura.

Armstrong Whitworth (Metal Inudstries) Limited, Close Works, Gateshead 8, County Durham.

Wind Loads on Tall Buildings

The Building Research Station of the Department of Scientific and Industrial Research is to carry out experiments on several tall buildings in Central London to measure the intensity and pattern of the wind loads.

The new fifteen storey headquarters of the Department of Scientific and Industrial Research in High Holborn, London, will be one of the buildings used. Circular plates of aluminium, let in flush with the windows and supported by springs, will record the wind pressure electrically. It is intended to record automatically whenever the wind pressures are high enough. The measurements will indicate the size and duration of the gusts, and the consequent pressure changes as they move around the block.

The present allowance for wind loading on buildings is governed by a Code of Practice issued in 1952, but which is now under revision. The current experiments should provide further information which will be taken into account in the revision. Other buildings which will be used in the experiment include the Millbrook Tower on the Thames embankment, the Barbican buildings in the City of London, and the circular transmission tower of the Post Office that is being built off Tottenham Court Road, London. This last building will provide data at a height of 650 ft and because of its relatively simple form, a circular tower, analysis of the effects will be particularly valuable.

Packaged Sewage-Disposal Plants

Packaged sewage plants which were first developed in the United States are now being manufactured in this country by Eimco (Great Britain) Limited, associate of the Eimco Corporation, and are offered as alternatives to cess-pits and septic-tanks.

The Eimco plants are manufactured in standard sizes with capacities ranging from 1,000 to 15,000 gallons per day. They are supplied as complete units ready to install. Larger plants up to 200,000 gallons per day can also be constructed.

The plant works on the aerobic digestion principle. It is divided into two parts by a baffle, one for aeration and the other for settling and clarification. Wastes enter the first tank and are aerated to encourage bacterial activity, and then passed to the second tank where they are allowed to settle. Settled sludge is returned continuously to the aeration compartment for 24 hours of aeration. Incoming waste is compensated by an equal overflow of clear and harmless waste from the top of the settling tank.

Rectangular tanks of ¼ in reinforced steel plate are used to build the plants. Multiple coats of coal-tar paint and a magnesium electrolytic element give corrosion protection. The sewage is aerated by a motor-driven blower mounted above the tank.

Eimco (Gt. Britain) Ltd., 190 Piccadilly, London W1.

Fire Resisting Building Boards

Two new products have been developed by Mandoval Limited (part of the Rio Tinto Mining Group) that will resist fire. The first—vermiculite asbestos cement wood fibreboard—will withstand 900° to 1,100° C without failure and will not disintegrate when subsequently immersed in water, in spite of the fibreboard content.

Thermal shock, as produced by the sudden application of a water jet from a fire hose, may produce local cracking of top layers, but there is no dangerous splintering. The manufacturers claim that the board is cheap to make, that it can be cut, nailed or screwed, and that it gives normal insulating board performance.

The second product, known as Sundeala flameproofed fibre building board, is the first board to be integrally flame-proofed to Class 1 standard during the ordinary process of manufacture. Boards produced by the new process are permanently flameproof.

In fire destruction tests, the new material is described as having remained as a " ceramic " shell after all wood content had been consumed.

Mandoval Limited, Barrington House, 59 Gresham Street, London EC2.

Bailey Bridge Gantry Erects Concrete Arch

During the construction of the new Donnington bridge for the City of Oxford, Bailey bridge units are being employed to assist place precast concrete arch members weighing 22 tons each.

The Bailey units were assembled to form a 75 ft span travelling gantry. The concrete members are the crown sections of the arch which is self-supporting when the side members are in position. Prior to erection, the precast units were floated into the river on Bailey pontoons and then lifted into position on to temporary trestles, as shown in the illustration.

Precast arch units lifted into position by the Bailey bridge gantry.

The gantry and trestles are on hire from Mabey and Johnson, 54 Victoria Street, London SW1. The main contractors are the Cementation Company Limited, and the consulting engineers Travers Morgan and Partners of London.

Scots Engineers and One-Off Tradition

A report on the Scottish economy calls for revolutionary changes in attitude to internal growth, trade and the outside world, and challenges some of the most deep-seated traditions of engineering practice north of the border.

G. E. Tewson, M.A.

WHENEVER engineers are gathered together in significant numbers anywhere in the world there are likely to be Scotsmen among them and a proportion of them are likely to have an engineering degree from one of the Scottish universities, especially from Gilmorehill. They are the product of an engineering tradition which has flourished in Scotland's narrow industrial belt, mainly between the Clyde and the Forth, for a century and a half. That tradition has always rated high quality work, craftsmanship and the production methods of the "one off." The products of this tradition have rarely had to be sold by men as other mortals have had to sell other products. Customer and producer alike know a good thing when they see it and that has been the bond of the market.

VITAL AWAKENING

If engineers reared in this tradition turn to the *Report on the Scottish Economy* (published recently by the Scottish Council (Development and Industry) at 25*s*), they will come upon a serious challenge to their ways of thinking. This report, prepared by a committee under the chairmanship of Mr. J. N. Toothill (himself a qualified engineer and accountant), has already had a wide publicity in the Press for the new ground it breaks across an already somewhat over-ploughed field. But it should be realized that it is above all a challenge to the Scottish professions—especially those of engineering and accountancy. The Toothill report states emphatically that if their recommendations are broadly followed, the economy of Scotland can "take off" (to use one of Professor Rostov's signature phrases) in five years.

After a lucid analysis of why Scotland is becoming more prosperous more slowly than other parts of the country, they reject the idea that the cause is a comparatively high rate of unemployment which they say is only a symptom of a deeper malady. This they consider to be the lack of "growth industries." Their prescription is how to attract such industries, how to create an economic and social atmosphere where such can flourish, where the emphasis is on flexibility of outlook and enterprise, and where dying growth can be encouraged to wilt to death so that the young, vigorous shoots can attract the sap and develop.

Having made their diagnosis they have this to say about their plan: "The danger lies in attempting a little now and a little later in the hope that in time it will be enough. . . . The answer is not the application of a dramatic remedy but a simultaneous attack at a large number of points. Some measures are primarily for Government action, some primarily local, some are a combination of both; but if they are to be successful the whole community must work together wherever the prime responsibility happens to lie in a particular case."

They then delineate the parts which various organs of government and vested interests have to play. They assign an important role to the Government, especially to the Board of Trade, but they recommend no increased ministerial representation for Scotland.

GROWTH HANDICAPS

Some of the severest strictures they reserve for the local authorities' policy of subsidized housing which they say, and rightly, has reduced mobility of labour and given misguided blood transfusions to decaying communities. Glasgow comes in for particular mention, not because Glasgow itself is dying (it clearly is not) but because it is so much the largest conurbation in Scotland, with the biggest problems of overspill and one of the worst records on rent subsidies. The committee could not say so, but stirring local government to a change of attitude will be one of the slower and more heartbreaking tasks of education under the plan.

This leaves for consideration industry and the community in general. That is to say, if the morale of the community is to be sustained at a new, aggressively constructive pitch of endeavour it will have to take its cue from industry, by which is meant the managerial, technical and accounting side, along with the unions.

Here is the nub of the report. A great deal of it is taken up with why "growth industries" have failed to come to Scotland, how they should be attracted and what that means in terms of managerial attitudes, training, apprenticeship, human relations and research. If the professions concerned in Scotland are to play their part in a great economic revival they must grasp the implications for themselves in what the report prescribes. Behind the simple idea of a "growth industry" for the mid-20th century, in an area with a high repute in heavy engineering, lies an industrial revolution which has scarcely begun.

According to the committee, Scotland (and similar parts of the country) have failed to get modern "growth industries" because there is too big a gap between the technological and managerial thinking in these industries and that in the old industries. The intellect and imagination cannot bridge it and therefore it is useless to expect glibly that a company can diversify easily from one into the other. The old-established heavy engineering industries were "one-off" or "batch" industries selling a "bespoke" product to a knowledgeable buyer. The modern "growth industries" are makers of consumer durable goods selling to mass markets, using new ideas of production control to make a standard article and different sales techniques to get high volume sales. Alternatively they are new chemical industries and the like, using modern research facilities on a grand scale with ample resources of new types of craftsmen and accustomed to a fairly frequent interchange of technical personnel by competition in the salary market. Such industries Scotland has not got on any scale: such industries she must have.

SPECIALIST MANAGEMENT

All this means a change in the technical environment for engineers in Scotland. Putting aside conventional professional labels for a moment, the new age is the age of the chemical engineer, the production engineer, the project engineer, the specialized mechanical, electrical and civil engineers—in short there must be more specialists.

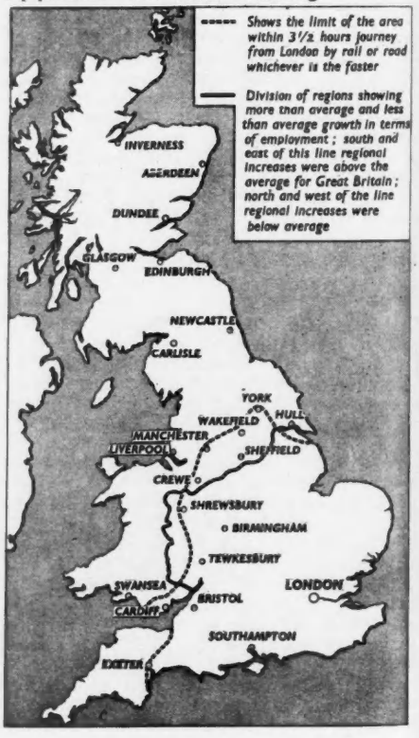
But it goes further than that. These specialists are needed not only as technologists. They must aspire to and percolate into top management. There is a new management structure to be made the vogue. All this is easy enough in theory but it is not easy in practice for it cuts across a powerful tradition, a conservative tradition. It involves a fairly swift conjuncture of a technical and managerial revolution and the gradual abolition of nepotism, out-of-date management controls and skimping on qualified staff. Of the report's 81 recommendations 39 deal with education, training and management; there is a stinging attack on the present apprenticeship system.

Part of Scotland's problem is isolation. The report says that poor delivery in and out of the country is a bigger handicap than any cost disadvantages. Understandably, therefore, it has much to say about opening up communications, and it enumerates roads, railways and air passages. Scotland, at the verge no doubt of entry into the European Common Market, needs to be able to establish its contacts more closely with the Continent. There are historical precedents enough in the Auld Alliance with France, the friendship with the Low Countries and the old North Sea trade.

Great stress is laid on personal communication. The accompanying map taken from the report shows a line drawn at 3½ hours' journey by rail from London compared with a line dividing the more-than-average from the less-than-average rate of growth measured by employment. They are not far apart and the committee has used the point to show the pull of London both commercially and in terms of research activity and Government head offices. They recommend Scotland to live with this fact, exploit it to its advantage and not fight it. This is stern doctrine for a race which will doubtless note that the map shows where Bonnie Prince Charlie got to in 1745 before he retreated north again!

The great danger is that the report will touch off more controversy than action. It has been written for a contentious race and there is plenty to argue about. The nationalists, the nationalizers, the trade unions and the Highlands ameliorators will dislike much of this essay in vigorous 20th century capitalism with its pleas to live with the "pull" of London and to finally destroy the "Border." But for some, its call to stop using England as an economic standard (where goodness knows there is enough anxiety about what the European Common Market will do to the cosier industries in the south) and to set Scotland's sights high because it *is* Scotland, should strike a chord.

The professional men, in the widest sense of the word, have now a key role to play if the Toothill report is to sound a call to action, and action will require courage. If there is a response "Scotland the Brave" will become more than a pipe tune. The world is watching.



Companies

Getting Key Workers Means Getting Houses

An offer to purchase Lion Works, Newtown, Montgomeryshire, from Raleigh Industries Limited, Nottingham, has been made by Guest, Keen and Nettlefolds Limited through their subsidiary firm GKN Group Services Limited. Subject to the finalizing of the details of the contract, the purchase is likely to be completed early in the New Year.

It is the intention of the Guest, Keen and Nettlefolds group, whose headquarters are at Smethwick, Staffordshire, to set up additional manufacturing facilities for certain of their subsidiary firms at Lion Works.

Every effort will be made by the GKN group, in cooperation with Raleigh Industries, to offer employment at Lion Works in due course to as many workpeople as possible. It will be some months, however, before the requisite production equipment can be installed. Resulting from this position, it is unlikely, the GKN group believe, that any substantial proportion of the existing labour force at Lion Works can be absorbed during the initial period of adapting the works to their new purpose.

Taking a longer view, the group are of the opinion that the new activities at the works will be of considerable benefit in improving the economic and social problems of Newtown and the surrounding area. At the same time, they point out that the completion of the arrangements they have in mind and the rate of growth in local employment must depend in a large measure upon the availability of a limited number of houses for certain key workers who will have to be transferred from the Midlands.

Negotiations with this end in view are accordingly being commenced by the GKN group with the local authority concerned.

Hadfields Sell to Escher Wyss of Zürich

Negotiations were concluded earlier this month as a result of which Escher Wyss Limited of Zürich, Switzerland, were enabled to purchase from Hadfields Limited, Sheffield, just over 3,050,000 ordinary stock units of 2*s* 6*d* each in Millspaugh Limited, Sheffield, for £1,200,000.

The purchase represents 60 per cent of the total issued ordinary stock of Millspaugh, but Hadfields are continuing to hold approximately 33 per cent of Millspaugh's capital and they will be represented on the Millspaugh board of directors.

As part of the agreement, Hadfields are to receive from Millspaugh during the coming twelve months the repayment of the whole of the sums still outstanding to them from that company, amounting to some £1,260,000. These amounts represent the balance of loans to Millspaugh during the last few years.

In a recent statement to his shareholders on this matter, Sir Peter Roberts, chairman of Hadfields, points out that, as a result of the transaction, the total cash resources of his group will be increased by approximately £2,400,000, but that an overall capital loss of around £320,000 will have to be borne by Hadfields.

The problem of providing sufficient additional funds for financing the development of both Hadfields and Millspaugh had been a matter of concern to the Hadfields board. In the case of Hadfields, substantial sums are still required for modernization purposes and for the expansion of production facilities, apart from the expenditure on capital account which the group have incurred during past years.

At Millspaugh, the provision of finance, not only for capital purposes but also for the increasing number of deferred payment commercial contracts, has been an important consideration. During recent years, finance for the latter purpose had been largely obtained by bank borrowing, in consequence of which an overdraft had resulted.

It was in the light of this position, that the Hadfields board welcomed and accepted an offer made by Escher Wyss.

The Future of Millspaugh Subsidiaries

Arising from the sale of the Millspaugh shares, the subsidiary concerns belonging to that firm are due to leave the Hadfields group.

At the request of Escher Wyss, however, Hadfields have purchased the investment of Millspaugh Limited in their two wholly-owned Canadian companies: HMK Sales Limited, which is a selling organization, and The William Kennedy and Sons Limited, which is a manufacturing company located at Owen Sound, Ontario. These purchases are, of course, subject to the approval of the British Treasury.

During the twelve months ended 30 June, 1961, William Kennedy made substantial losses owing to the difficult trading conditions existing in Canada. It was considered that the fortunes of this firm were unlikely to change materially in the immediately foreseeable future and Hadfields explored the possibility of effecting a sale.

The Black-Clawson Company in the United States expressed an interest and agreement has been reached with them to purchase the whole of the William Kennedy shares and, as a result, William Kennedy will no longer be a member of the Hadfields group. This agreement also is subject to the approval of the Treasury.

A capital loss of approximately £290,000 will be incurred by Hadfields in respect of this sale.

The position of HMK Sales has not yet been resolved and will depend on the future prospects of Hadfields's and Millspaugh's products in the Canadian market.

Millspaugh's existing services and facilities will be continued by agreement and Hadfields and Millspaugh will cooperate on all matters of common interest. Millspaugh will be free to arrange their own finance. This, combined with their knowledge and experience, and that of Escher Wyss, especially in regard to pulp and paper-making machinery, will be a source of strength to all three organizations.

Grouting Services from the United States

A new company has been formed to provide the Intrusion-Prepakt grouting services in Great Britain. The firm will be known as Intrusion-Prepakt (UK) Limited and is an associate company of Intrusion-Prepakt Incorporated of Cleveland, Ohio, USA, who have set up similar links with many other countries outside the United States. The address of the new firm is 66 Silver Street, Enfield, Middlesex.

Services provided by the organization include such activities as underwater concreting, the stabilization of loose sands underneath bridges, the consolidation of existing ballast stratas, the provision of water-retaining barriers to allow excavation work to proceed, and the filling-in of foundation cavities of various kinds.

Intrusion-Prepakt equipment enables cement and sand mortar to be injected directly into preplaced aggregate for the production of concrete. Mixed-in-place and cast-in-place piles can also be provided in a wide variety of soils for such purposes as load bearing and underpinning.

It is stated by the organization that their piling technique is completely free from vibration, thereby allowing piles to be placed adjacent to existing structures with the very minimum of danger or damage.

A group of completed 44,000 volt bushings undergoing a 24 hour test for oil tightness. They are typical of the low-voltage bushings being supplied by the English Electric Company for transformers in New Zealand.

When Oil Tightness is Essential

Shown in the accompanying illustration is a group of completed 44,000 volt bushings undergoing a 24 hour pressure test in order to determine their oil tightness.

The test is taking place at the bushings and ceramics division of the English Electric Company Limited at the firm's works at Accrington. Depending upon the type of bushing an internal or extreme pressure of ten pounds per square inch is applied and it is an essential requirement that there shall be no oil leakages during the 24 hour period.

The specimens shown are typical of the low-voltage bushings currently being supplied by English Electric for transformers for New Zealand.

A Number of Company Changes

Sir John Macpherson, who was the first Governor-General of the Federation of Nigeria and, subsequently, Permanent Under-Secretary of State for the Colonies, has been appointed chairman of Cable and Wireless Limited, London WC1, and their associated companies, in succession to the late Sir Godfrey Ince. He will assume his new post at the beginning of next month.

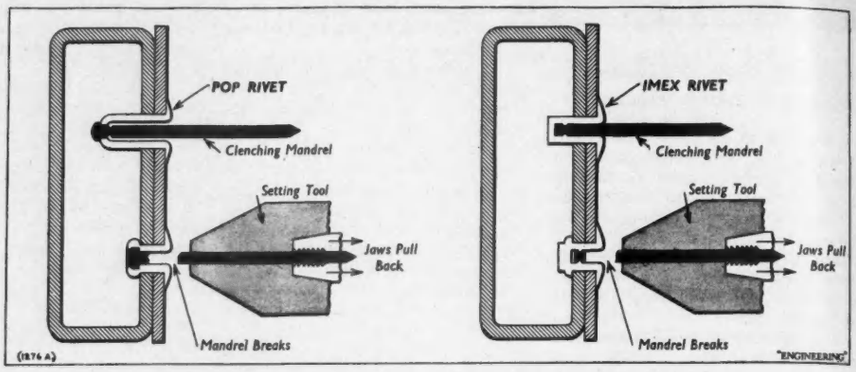
Mr. H. D. Byles has been appointed managing director of Packman Machinery Limited, of Twyford, Berkshire, one of the companies in the Baker Perkins group. His appointment will allow Mr. P. J. Packman, who becomes chief engineer and technical director, to devote his full time to the design and development side of the business. The headquarters of Baker Perkins group are at Westwood Works, Peterborough.

Armstrong Whitworth (Metal Industries) Limited, Close Works, Gateshead 8, have appointed Mr. J. Arnold Needham as technical sales engineer of their soils compaction division, in succession to Mr. Frank Nattrass.

As from 1 January, sales representation in the United Kingdom for the Churchill Machine Tool Company Limited, Broadheath, Manchester, will be carried out by Burton Griffiths and Company Limited, Mackadown Lane, Birmingham 33.

Uses of Old and New-Type Blind Rivets

Where watertightness is desired it is better to use the new Imex rivet than the long-established Pop rivet. Uses of both are described.



DEVELOPED for the aircraft industry before the Second World War, the Pop rivet has been adopted by many other sections of the engineering industry, say Geo. Tucker Eyelet Company, the makers. It is widely used for joining the lighter types of metal sheets and sections.

The Imex rivet is a recent development and differs in that it has a sealed end. This, combined with the high rate of radial expansion in setting, is said to ensure a completely water and airtight joint which renders the rivet particularly suitable for roofs, boats, tanks or pressurized assemblies where the weatherproof effect of the Pop rivet is insufficient.

The manner in which these two types of rivet are set is illustrated here. They can both be used blind in that they can be inserted and set from one side of the workpiece only. The advantages of blind riveting are that it saves the cost of having two operators and that it makes some operations possible which would not otherwise be so due to inaccessibility. Tucker Eyelet comment that the speed and simplicity of the process make it attractive even where both sides *are* accessible. A further advantage is that the gradual clenching action of the rivet ensures freedom from distortion of the structure which sometimes occurs in thin sheet metal when it is riveted or welded.

Pop rivets are made in aluminium alloy (B.S. Specification L58), copper, mild steel and Monel in diameters from $\frac{3}{32}$ to $\frac{1}{4}$ in and in lengths capable of riveting up to $\frac{1}{2}$ in material thickness. All sizes are available with domed or countersunk heads.

Imex rivets are also made from aluminium alloy and copper. They are made with two types of setting mandrel: the short-break type (illustrated here) fractures immediately adjacent to the mandrel head and is supplied for general use. A long-break type fractures outside the rivet so that the protruding portion can be nipped off and sanded down to give a flush finish. The retained portion of the long-break mandrel forms a solid steel core which, according to Tucker Eyelet, adds considerably to the ultimate shear strength.

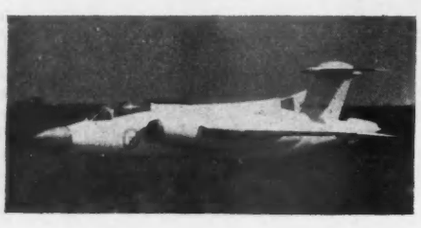
Tools are available for setting both types of rivet. Hand tools can be supplied for site work whilst pneumatic or hydraulic tools are more usual for mass production.

In addition, a range of attachments is made which permits riveting in inaccessible positions such as around corners or into channel sections. *Geo. Tucker Eyelet Company Limited, Walsall Road, Birmingham 22B.*

Riveting Rudder and Aileron Skins

Blackburn Aircraft selected Imex long-break countersunk head rivets for riveting the external skins of the rudder and ailerons of their new Buccaneer aircraft. This is now in production for the Royal Navy.

Tucker Eyelet comment that these were chosen because they offer strength to withstand the stress of high speeds and offer a flush finish which eliminates drag on external surfaces. In aircraft frame construction generally, they add, both Pop and Imex rivets are widely used.



Mass Fixing of Clips on to Cars

One of the items which has to be fixed quickly and economically on the mass assembly lines

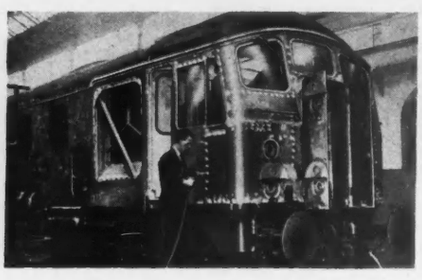
of modern cars is the decorative moulding attached by clips to the exterior of the car body.

British Motor Corporation have selected the Imex or Pop rivet for fastening clips to all their models one of which is shown in the illustration above.

Tucker Eyelet said that this type of rivet was chosen in view of its ease and speed of setting combined with the fact that its sealing action would eliminate the possibility of water gaining access to the body interior. In positions where watertightness is not so important Pop rivets are used by many motor car manufacturers for attachment of gutter mouldings, rubber boot or bonnet strips, kick plates, nameplates and heaters.

Fixing Panels on Locomotives

The illustration below shows external aluminium panels being fixed to the driving cab of a 1,200 hp diesel-electric locomotive under construction at the locomotive works of British Railways at Derby.

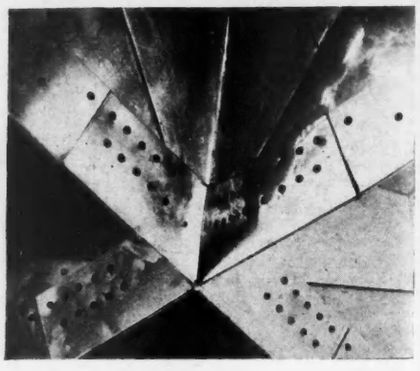


British Railways, it is reported, were concerned to obtain a rivet with a high strength/weight ratio to withstand the stresses encountered when, for instance, the locomotive enters a tunnel at speed. The rivets should not cause distortion of the panels in setting. Tucker Eyelet say that British Railways have found the high strength and gradual setting action of the Imex and Pop rivets ideal for their purposes.

Uses by Building Industry

The building industry has for a number of years used Pop rivets in metal roofs, ceilings, walls, doors and windows, say Tucker Eyelet. Indeed, the prefabricated metal bungalows erected in the immediate post-war period were more or less entirely assembled with Pop rivets. The roof of the famous Dome of Discovery erected at the South Bank site in London for the 1951 Festival of Britain was also fastened with Pop rivets.

The Sixth International Congress of Architects was recently held on the same site and Imex rivets were used in the construction of the novel Pyradek roof of the building. Tucker Eyelet say that these rivets were used because they gave watertightness in the gutters and permitted even unskilled labour to make strong joints.



Electrolytic Heavy-Gauge Tinplate

Steel Company of Wales have announced that they can supply electrolytically coated tinplate up to 0·0237 in thick. In this thickness, at a price of less than £60 a ton, the makers expect that the material will be attractive for many applications where hitherto the price of hot-dip tinplate has been prohibitive.

By the electrolytic method, coatings as low as 4 oz per basis box can be achieved. In terms of straight corrosion protection it should be remembered that the thinner coatings give less protection. However, Steel Company of Wales say that tinplate provides good paint adhesion, suitable surface conditions for processing and plating, excellent ductility and a saving in die costs since the tin coating acts as a lubricant.

In the USA where electrolytic tinplate has been available for some time, it is reputedly being used by makers of automobile accessories for heaters, valve rocker covers, frames for rear view mirrors, headlight reflectors, air and oil filters. Other uses are said to include acoustic ceiling panels, wall tiling, ventilators, fluorescent lighting, venetian blinds as well as parts for domestic and office equipment.

Steel Company of Wales Limited, Abbey Works, Port Talbot.

Fuel Additive Wins Approval

Amber Chemical Company say that the Aluminium Company of America have approved their Fuel Additive SSR509 for use in the Alcoa fleet of ocean-going vessels. The Alcoa Research Laboratories have asked the American Licensees of Amber Chemicals whether supplies can be made available in New York, Philadelphia, Mobile, Trinidad and Puerto Rico.

The Alcoa fleet uses Bunker C fuel oil. Amber Chemicals say that the effect of the addition of small quantities of SSR509 is to suppress the formation of corrosive combustion acids, to disperse sludge and impart better flow properties, and to reduce soot and smoke. Also, because combustion is improved, preheating temperatures can be reduced, they claim, and carbon deposits on heating surfaces are less in quantity and more friable in nature.

Amber SSR509 is one of a series of liquid and solid combustion improvers sold in the United States by D. A. Stuart Oil Company.

Amber Chemical Company Limited, 11a Albemarle Street, London W1.

Degreasing and Derusting Steel

It is claimed that degreasing, derusting and descaling of ferrous metals can be performed simultaneously in one tank with two solutions developed by Grant and West. A water rinse is required.

The two solutions, known as ChemiClene No. 437 for the removal of oil, grease, light rust and welding scale, and ChemiClene No. 447 for removing oil, grease, heavy rust, welding scale and millscale are said to cut the cost of multiple bath processes.

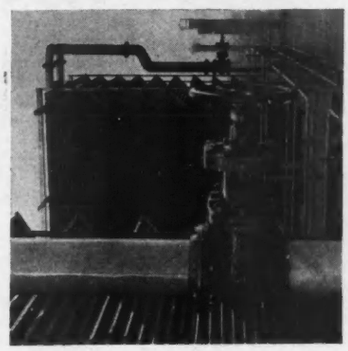
Both solutions work on the same lines. Diluted with water and heated to between 40 and 50° C, they emulsify the oil and grease so that they are removed in the following water rinse. At the same time rust and scale are removed by chemical action.

The time taken will vary according to the amount of contamination. Grant and West say that with ChemiClene No. 437 the average time should be between 3 and 8 minutes, while with ChemiClene No. 447 oil, grease and light heat-scale are removed in 10 to 15 minutes. The low operating temperature of these solutions has the added advantage of eliminating vapour problems and making extraction plant unnecessary, say the makers. ChemiClene No. 437 is non-corrosive so that it is suitable for treatment of partially fabricated work where some of the liquid could be trapped between seams and welds.

Grant and West Limited, Stoke Mill, Guildford, Surrey.

Pvc Pipe on Cooling Tower

At the Motherwell plant of Colvilles, it is reported that metal pipes used on the 120 ft high water cooling towers had a life of only five years. When the company came to design a new cooling plant for their No. 2 plate mill development they chose 10in high-impact pvc pipe together with sprinklers in the same material.



This use of pvc pipe is expected to eliminate the replacement of pipe or fittings, say British Geon, suppliers of the pvc compound from which the pipes were made. Pipe, sprinklers and fittings were manufactured from the Geon material by Extrudex Limited.

British Geon Limited, Devonshire House, Piccadilly, London W1.

Publication on Aluminium Bright Trim

Aluminium Development Association have published their application brochure number 15 entitled "Aluminium Bright Trim" (10*s* 6*d*). This, they say, is primarily addressed to manufacturers of finished products and accessories having trim items, but also provides information for installation contractors, distributors and agents.

ADA say that the brochure can be used as the basis of a specification covering materials designed for bright trim application. In one appendix data are presented on mechanical properties of the various bright trim alloys, and in another appendix appropriate quality control and test methods are described. The brochure is illustrated with applications.

Aluminium Development Association, 33 Grosvenor Street, London W1.

Aluminium Bright Trim from New Factory

London Aluminium Company have started production in a new factory in Wombourn. The three bay shop they now occupy covers 140,000 sq. ft, but there is said to be a much larger acreage at their disposal on the same site for eventually rehousing their existing factories from other parts of the country.

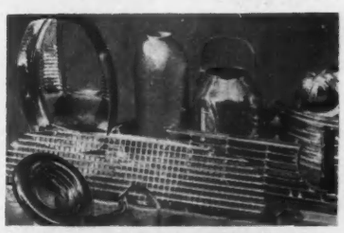
Of particular interest in this factory is a chemical polishing and anodizing plant built for them by Albright and Wilson described later in this note.

The main facilities which feed this plant and other manual finishing sections include six new presses each with a capacity of 350 or 500 tons. London Aluminium undertake a wide range of projects including pressings, spinnings and brazed parts. A group of their products can be seen in one of the illustrations below.

The automatic chemical polishing and anodizing plant is reputed to have cost nearly £150,000 although this was described by the company as a very comprehensive price. It is said to be the first one to be operated in this country which is fully automatic. Some 78 ft long, 16 ft 6 in high and 12 ft 6 in wide, the complete plant weighs well over 100 tons.

The plant is designed around the use of Phosbrite 159 which is the chemical polishing solution sold by Albright and Wilson. In this plant it is followed by sulphuric acid anodizing. It is claimed to have a total output of thousands of sq. ft of polished and anodized aluminium a day, in other words, to be sufficiently large to seriously interest car firms whose demands are large.

There is a practical limit to the area of aluminium which can be chemically treated in a Phosbrite bath of given capacity, and London Aluminium say that this plant is already being operated for 2½ days a week. Thus, further



plants may have to be built if this one is a continued success.

The conveyor system has been brought over from America according to London Aluminium and it appears fairly simple to reorganize the sequence and size of each bath should this ever be thought desirable. It works on a regular lift/move forward/and-lower cycle on a fixed time interval of about 30 sec. In the anodizing bath the lifting and lowering is omitted except on entry and exit as it extends over several cycles.

The Phosbrite dip occupies just under two cycles or about a minute and fine control of this is arranged by means of a delayed set-down mechanism on entry. The complete sequence of baths is as follows: 3 alkali soaks, cold water rinse, nitric acid desmut, hot water rinse, chemical polish, hot water rinse, nitric acid desmut, two cold water rinses, hot water seal, hot air dry. The second illustration shows radiator grilles leaving the multi-station anodizing plant prior to rinsing and hot water sealing.

Considerable attention is said to have been given to the materials of construction of the plant. Stainless steel (En58J) has been used for the chemical polishing tank, the nitric acid desmudges and the hot water rinse tanks, whilst the cold water rinse tanks have been lined with white pvc or lead according to the type of treatment preceding the rinse. The anodizing tank is rubber lined steel, the current being supplied via fitted lead cathodes. Fume removal ducting and hoods have been made from pvc throughout except on the hot seal tank where stainless steel hoods are used.

London Aluminium Company Limited, Bridgnorth Road, Wombourn, Staffs.

Albright and Wilson (Mfg.) Limited, 1 Knightsbridge Green, London SW1.

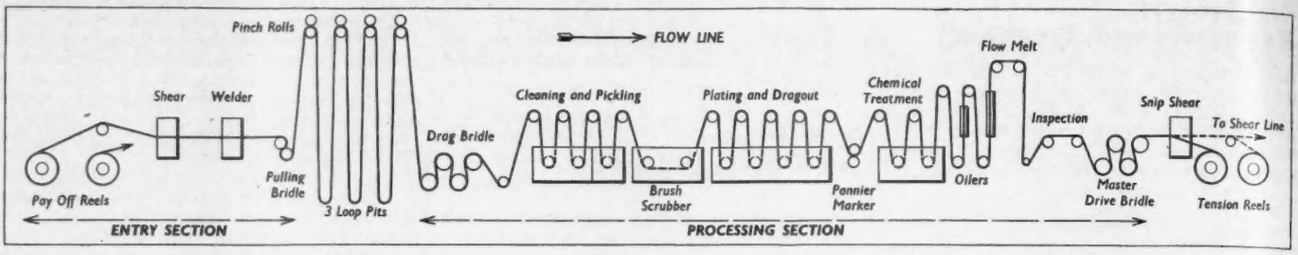


Fig. 1 A flow diagram of the No. 2 Ferrostan electrolytic tinning line now in full production at the Ebbw Vale steel works.

New Vistas in Electrolytic Tin Plating

A new electrolytic tin plating line, now in full production at a British steel mill, is the biggest of its type in the world. It is two and a half times as fast as a comparable line built shortly after the War and gives double the thickness of plating.

THE No. 2 electrolytic tinning line which is now operational at the Ebbw Vale, Monmouthshire, plant of Richard Thomas and Baldwins is producing tin plated strip continuously at 1,500 feet per minute, with provision for a later increase to 1,700 feet per minute. Fundamentally, this line uses the same Ferrostan process—a process developed by the United States Steel Corporation—as the No. 1 line laid down at Ebbw Vale in 1947. Technical advances within the last decade, however, have been so great that this latest line, which is said to be the largest of its type in the world, is two and a half times faster than the earlier line. Another advantage of the No. 2 line over the No. 1 line is that it can apply up to 1 lb, as compared with ½ lb, of tin per "box" (a unit used in the industry to represent 217 square feet) of tinplate.

Design of the plant was by the Head Wrightson Machine Company Limited in conjunction with a division of the Blaw Knox Company of Pittsburg, USA.

THE PROCESS

There are four basic lines in the overall tinning process. These are (a) a coil preparation line, (b) the Ferrostan electrolytic tinning line proper (an outline of which is shown in the flow diagram in Fig. 1 above), (c) two tinplate cut-up lines, and (d) an inspection and assorting line.

The steel strip received from the cold mill for tinning varies in width from 18 in to 38 in and in thickness from 0·006 in to 0·0239 in. Improved designs of pay-off and tension reels, and of seam welder and edge trimmer have been developed for the coil preparation line, giving it a top speed of 4,000 ft per minute. Finished coils weighing up to 36,000 lb. are transferred by overhead crane to inter-operational storage on a horizontal conveyor with a built-in weighing machine.

These coils then pass on to the electrolytic tinning line to begin the process outlined in Fig. 1. They are mounted on one of two alternative pay-off reels—the reels are used in turn to maintain continuous flow into the line—and each coil is fed by electrically driven pinch rolls to an air operated double cut shear which trims the leading edge preparatory to welding it to the tail end of the preceding coil.

Since the line must be halted momentarily at this initial shearing and spot welding station it is necessary to provide some "slack" between this station and the next operation in the process. For this reason, a reservoir of 500 ft of strip is held in three free loops contained in a looping pit which is 80 ft deep and has controlling pinch rolls mounted 25 ft above the mill floor. Accelerated entry of strip into the loops is controlled by a pulling bridle while a drag bridle at the exit end of the loops feeds strip into processing.

As shown in Fig. 1, on leaving this drag bridle the strip is taken through cleaning and pickling; brush scrubbing; plating and dragout; pannier printing; chemical treatment; flow melting (to give a bright surface); electrostatic emulsion oilers and driers; inspection; and, immediately before shearing into coil lengths, the master drive bridle. During these operations the strip takes an undulating path over or under some 85 rolls, the tension and motive power being provided by the drag and drive bridles, but the individual rolls are also driven by 5 hp electric gear motors to overcome inertia and ensure that the tension bridles will provide invariable tension and correct tracking at all times.

In fully utilizing high-speed plant such as this processing line it is economically critical that down-time should be reduced to a minimum and, therefore, that maintenance should be as easy as possible. To meet this urgent need, therefore, the tanks in the new line have been raised above the shop floor with an operating platform 10 ft 9 in above floor level and 30 ft wide running the full length of the process.

Three new specially designed large plating tanks are incorporated in the line giving a total of 24 plating passes, though all of these will be needed for only the heavier coatings. Replenishment of tin anodes on the 48 bridges is continuous, small hydraulic jacks on each bridge being used to assist in pushing the banks of anodes across the bridges. During plating with all 24 passes at 1,500 ft per minute up to 1 lb of tin per box (217 sq ft) can be applied to the two sides of the strip with the proportional amounts on each side adjustable as required, in the case of differential tinplate.

Another development introduced with the new Ferrostan line is an inspection unit consisting of two 15 ft vertical mirrors with which the inspector can see both sides of the strip. For more detailed inspection, a pair of scanning units is provided, consisting of a rotating drum synchronised with the strip speed. The drum surface carries 20 small flat mirrors which reflect briefly a stationary image of the moving strip.

A record of the quality and quantity of each coil of strip is obtained from a production analyser, installed by the English Electric Company, which automatically tabulates total length, prime length (the length passed by inspection), pinholed length, over-gauge length, and under-gauge length. Each coil length is run off on to one of two tension reels and snip-sheared.

The speed of the Ferrostan line is such that a single cut-up line could not handle its output. There are therefore two cut-up lines, though one of them is placed in line with the electrolytic tinning plant so that, with the use of a looping pit, it can receive strip directly from the master drive bridle on the tinning line when the latter line is running slowly enough. Normally, however, the strip is taken to the cut-up lines in coils. Use is made on the cut-up lines of tape produced on the tinning line by a data recorder which notes lengths of rejected material. This tape feeds its information to a four-pile classifier after shearing so that individual sheets are sorted into "primes," "pinholes," "off-gauge" and "menders." The sheets are diverted into these piles by electro-magnetic rolls which can pick out a single faulty sheet at speeds up to 1,000 ft per minute. Faulty sheets are then re-sorted, on the inspection and assorting line, into sheets which can be sold as "seconds," those which can be reclaimed by hot dipping, and scrap.

THE IMPLICATIONS

The market for tinplate is vast. It is used for canning foods such as vegetables, meat, soups, fish, beer, milk and soft drinks; for closures such as crown corks; for containers for oil, paint and polishes and for biscuits and dry foods; and for kitchen ware, trays, canisters and toys. For some time, the demand for electrolytically coated plate in particular has been increasing rapidly, and in the USA, where the process has been very highly developed, about 95 per cent of tinplate is produced electrolytically.

Now, with their new Ferrostan line, Richard Thomas and Baldwins, originally the first company to introduce electrolytic tinning to this country, have taken another step forward, increasing the proportion of tinplate produced electrolytically to 80 per cent of the company's total production. It is probable that hot dip plating will always be necessary for some purposes but the swing towards electrolytic plating for general applications is a measure of the technical advance made by the tinplating industry. *Richard Thomas and Baldwins Limited, Ebbw Vale, Monmouthshire.*

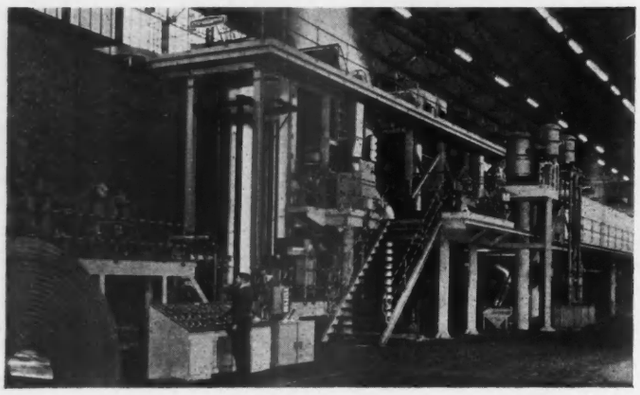


Fig. 2 A general view of the No. 2 Ferrostan tinning line. In the foreground is the data recorder console and beyond that the inspection pit and the raised gangway alongside the process vessels.

New Vistas in Aluminium Can Making

The aluminium can, though normally more expensive than the conventional tin can, is becoming more widely used. Two recent developments, a continuous strip lacquering line and double-drawing, will extend these uses.

IN THIS country, at least, it is unlikely that large scale production of aluminium cans will ever be as economic as that of tin plated cans because of the difference in cost of the basic material. In spite of this difference in cost, however, the aluminium can has properties which make it an attractive proposition for some specialised purposes. This proposition has currently become more attractive economically with the development by Aluminium Laboratories Limited of (a) a continuous strip anodising and lacquering line at the Rogerstone, Monmouthshire, works of their sister company, Alcan Industries, and (b) a method of double-drawing cans from ready-lacquered strip.

The significance of these developments can be seen in relation to the properties of the aluminium can. Being usually flow formed by drawing or extrusion, it has no side seams or bottom seam and is therefore strong for its size and thickness. It is light in weight, a factor which may represent a saving in transport costs, and it can be decorated by labelling or printing. There is no danger of corrosion and an aluminium can is easy to open.

The practical value of the aluminium can's properties is reflected in the fact that, during each of the past two years, there has been a 20 per cent increase in its use in Europe, though this is small compared with the 80 per cent increase in the USA. In Europe the most widely used types are cylindrical cans made by impact extrusion and shallow-drawn cans produced from pre-lacquered strip in a single draw.

A serious disadvantage with impact extruded cans is that they must be degreased, spray lacquered and stoved after being formed, a process which demands expensive equipment. At the same time, there has not been the incentive to develop deep-drawn cans from pre-lacquered strip because the demand for shallow-drawn cans has been more than enough to use up the existing manufacturing capacity for this strip.

With further production capacity for strip lacquering being developed, there is thus emerging a good reason—in fact, a powerful incentive—for going into the deep-drawn cans field.

THE ROGERSTONE PLANT

A central problem with double-drawn cans has been the difficulty of making two draws and still leaving the inside lacquer coat in a condition to protect the can from the product. At Rogerstone, the process illustrated in the flow diagram in Fig. 1 has overcome this difficulty.

In essence, the line consists of a series of units in which aluminium strip is successively washed, anodised, coated with lacquer, and stoved, to produce a lacquered strip known as "Anolac." Initially, the line is being used for coating material up to 26 in wide and from 0·008 in to 0·018 in thick, and with various lacquer.

As shown in Fig. 1, four drive units maintain the speed and tension of the strip through the double-decker process line. These units are time-controlled electronically to hold the speed and tension of the strip within prescribed limits. Infeed and outfeed accumulators or reservoirs are built into the line to provide 160 ft of slack at each end of the process.

The strip passes through alkali, hot water and cold water rinses and then, after drying, through anodising, a further water rinse, and drying and cooling. In the coater, lacquer is applied to each side of the strip through two sets of 3-roll reversible type rolls. Thickness of coating is metered by adjustable gaps between the rolls and the strip can be coated on one or both sides.

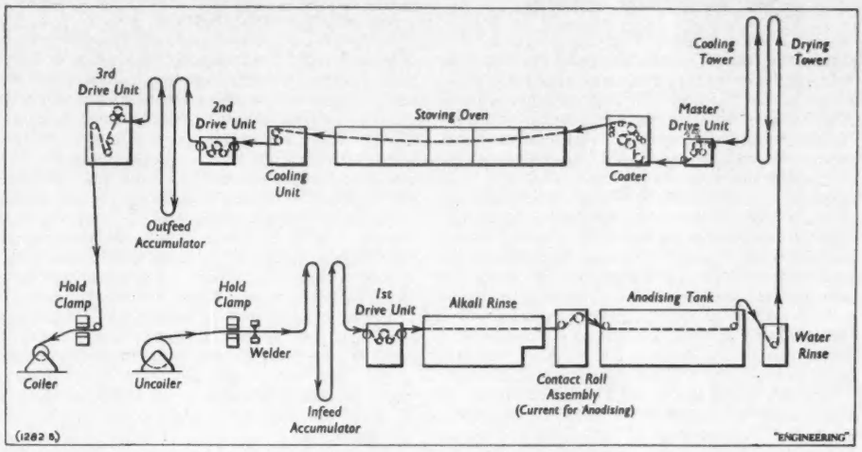


Fig. 1 A flow diagram of the two-level aluminium strip lacquering plant.

Stoving is carried out in a 70 ft long direct gas-fired oven with five zones to ensure controlled heat distribution at a temperature of 370° C. Stoving is the key operation limiting the whole speed of the process to something like 150 ft per minute and, indeed, special types of lacquer had to be developed in order to make the operation possible at this speed and temperature.

DOUBLE-DRAWN CANS

The prototype can-making line at Aluminium Laboratories (shown in Fig. 2) has been turning out cylindrical 6 oz cans with a length/diameter ratio of approximately 1 : 1 from a 0·012 in thick magnesium alloy. This line consists of two 60-ton mechanical presses operating at 90 strokes per minute and linked by a conveyor belt.

In the first press a circle is blanked from 6 in wide Anolac strip—after spray lubrication—and drawn into a cup with a 44 per cent reduction which is raised to the conveyor by an elevator set at such an angle that the cups can only be elevated when their centre of gravity is below their centre point—in other words, when they are the right side up. A low-friction nylon belt is used on the conveyor so that the individual cups retain their equilibrium during any bunching.

The single-drawn cups are then located in turn in the second press and drawn to their final size with a 24 per cent reduction and embossed, flanged and trimmed in one stroke of the press. Fig. 3 shows the cans after one and after two draws.

Though some intricate design work has been necessary on the dies, the presses and much of the auxiliary equipment are standard commercial units. The capital cost of the line, excluding lid making, is in the region of £7,000.

On this basis, it has been estimated that the cost per thousand 6 oz cans is £8 3*s* compared with £9 12*s* per thousand for making cans from plain strip and then degreasing and lacquering them. It has also been estimated that three-piece tinplate cans of this size normally cost approximately £5 11*s* per thousand. However, in view of the comparatively low initial cost of the new aluminium can line, it can be taken that this line could be an attractive proposition for outputs of up to 20 million cans per year.

In some circumstances—such as when cans have to be carried long distances—aluminium cans might be economic for larger quantities. In fact, some canning firms might be attracted by the idea of setting up their own can-making plant and buying in lacquered strip instead of completed cans. The cans made from pre-lacquered strip can be more easily handled mechanically than unlacquered cans and could be fed from the presses directly into canning lines. Another cost advantage with double-drawing pre-lacquered strip is that a harder—and therefore thinner and cheaper—alloy can be used.

Thus, it now appears likely that the special properties of aluminium cans combined with the economies now being made in their manufacture will guarantee them a share of the increasing market for cans in general. It is probable that tin will hold a good 90 per cent of the annual UK market of 600 million cans under 8 oz capacity, but American experience seems to indicate that a rise in demand for aluminium cans is a natural complement to an increased demand for tin plated cans. Indeed, the even steeper proportional demand for aluminium cans in the USA might be an indication that, as standards of living rise, so cost matters less and such qualities as lightness, ease of opening, and decoratively coloured lacquers matter more. If that is so, the long-term prospects for aluminium cans would seem to be very good.

Alcan Industries Limited, Banbury, Oxfordshire.

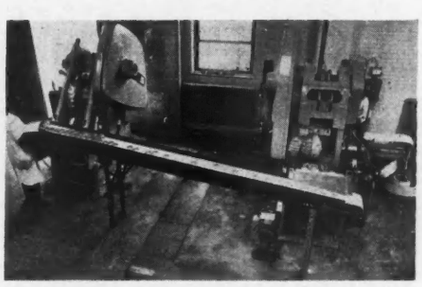


Fig. 2 The double-drawing line. Flow is from right to left.

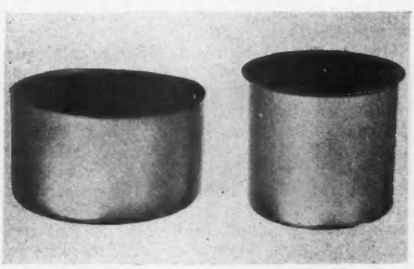


Fig. 3 An aluminium can after the first draw (left) and after the second draw (right).

On the Shelf

By Frank H. Smith

ONE thing is certain about this column and review copies. By the time they reach me there is no chance that they will jump the publication date. There are all sorts of implied dire results of mentioning on club tapes, broadcasts or in papers before 15 November *Automatic Data Processing* and I'm writing this much later. It costs 6*s* and comes from DSIR, so is bought through HM Stationery Office. It is a sort of 74 page un-indexed review of the state of the art and mentions names of manufacturers with an engaging freedom. The illustrations emphasize how soul-less and dehumanized these installations are. I wonder if operating these things has any effects similar to those of fall-out? That's what they used to say about radar when it was still RDF and they had a hell of a job to get volunteers.

A loose insert in the journal of the ICE is so unusual that it must be important. It is an application for membership of the British Nuclear Energy Society (1-7 Great George Street, London SW1) and on page 4 (Extracts from the Deed of Constitution) are enumerated 13 institutions (guess 3?) of which the members are eligible " and of such other societies and bodies corporate or unincorporate whose objects or purposes are of a scientific character as may be admitted as constituent bodies as hereinafter provided shall, on application to the Board, be admitted as members of the Society." With such possible latitude I fail to see why the particular 13 bodies named *are* named unless it is wrapped up in the Civil's presidential speech and subsequent correspondence in *The Times* round 13 November.

Guide to the Press of the World (Dawson's Little Red Book) for 1962 is now available from Wm. Dawson and Sons Limited, Cannon House, Macklin Street, London WC2. Contents are sectionalized according to country and I regret to say that there is no advert in the guide for the paper with the unsolemn colemn.

Such a mass of announcement comes from Pergamon that I became sated but I have flogged my digestive tracts for *Information Storage and Retrieval*, a journal due to appear in 1962. J. Farradane is editor-in-chief and I need say no more to make the interested ones don their spikes and run hot-foot to Headington Hill Hall, Oxford, for further dope (and I use the word advisedly). And by the way, Ian Maxwell is now Robert Maxwell so adjust your address books accordingly.

If you want Herbert's *The Engineer's and Mechanic's Encyclopaedia* in 2 volumes at £10 (1836) or Tredgold's *Elementary Principles of Carpentry* at 5 guineas, or Williams's *Our Iron Roads* (1852) at 6 guineas, you will be interested in and by catalogue 28 from W. A. Lee, 162 Byres Road, Glasgow, W2. For myself, I fancy *The Illustrated London News*, Vols. 2-14 (1842-9) at £20.

One of the stock catches in a library is to find ASM in the author catalogue. It is American Society FOR Metals, which puts it in a different place from where it would be if it were OF Metals. This irrelevance is merely to introduce their new catalog (*sic*) and price list obtainable from Metals Park, Ohio.

Owt for nowt department. 43-page catalogue, " Publications 1904-1960 ", from Engineering Publications, 114 Civil Engineering Hall, University of Illinois, Urbana, USA.

Breakfast foods get into everything. A news flash from Ferro Enamels Limited (Wombourne, Wolverhampton) tells of a vast new building, thought to be the only plant in the country that will produce glazes in flake form. " The reason for manufacturing in flake form is that it is considered to be a superior form to glaze frit manufacture. Primarily it is easier to grind in the customer's own plant, and grinds down more 'evenly' than frit." Paul Jennings where art thou? I'm all for a bit of frit myself.

Choosing Plant Materials

Materials Selection for Process Plants. By R. E. GACKENBACH. *Reinhold, New York; Chapman and Hall, London.* (68*s*)

The designer of modern process plant is continually faced with the problems arising from the use of higher temperatures and pressures and with the handling of new and highly corrosive products. With the development of new construction materials to meet these demands the designer's problem centres round the selection of materials to meet any particular set of conditions in the most convenient and economical manner. The ultimate choice depends upon an intimate study of process conditions, reinforced if possible by field evaluation, and on a knowledge of the properties and proved uses of the selected materials. The author of the present book has combined in a single volume just this type of information for a wide range of conventional and new materials. The approach is practical and only sufficient theoretical treatment is given as will be readily absorbed by the average reader.

The book begins with an outline of the different types of corrosion met with in process plant including galvanic action, stress corrosion, fatigue, etc. and the theories put forward to explain their occurrence. Methods of reducing corrosion by cathodic protection and the use of inhibitors are described and a very useful chapter is devoted to criteria for mechanical design by which attack may be minimized.

A large proportion of the book is devoted to the properties of a wide range of metals and their alloys. These include the more common steels, stainless steels, cast and wrought irons, aluminium, copper, nickel and lead, together with up-to-date information on titanium and zirconium and their alloys. For all these materials comprehensive information is listed regarding physical and mechanical properties. Particular attention is drawn to the fabrication techniques required by many of the alloys. Indications of their corrosion resistance to the more common inorganic and organic compounds and the effect of variation in chemical composition upon corrosion attack are all dealt with. Mention is also made of specific types of equipment for which they have most successfully been used.

The use throughout the book of American standards and American company trade names may cause some difficulty for the British reader. However, the comprehensive data given on chemical composition provides a ready method for cross reference to standard British materials.

The author points out that the cost of stainless steels and alloys varies considerably and that the final choice may often depend upon a balance of permissible corrosion and economic factors. Some quantitative information on the relative costs would therefore have been useful.

Concluding chapters are devoted to bricks and cements, plastics, rubbers and elastomers, and paints and coatings. Here again the book is notable for its inclusion of information on such new materials as " Hypalon," " Viton," and " Penton." Physical and chemical properties are listed for these compounds together with proved and probable fields of application.

Not the least important for a reference book of this type is the full and clear index which gives ready access to the information included. For all those to whom corrosion is a recurring problem the presentation of this information in a single volume fills a gap in the available literature. Plant designers and trouble shooters will find it of great practical value and it should make a strong appeal to the student in bridging the gap between theory and practice.

R. M. DANNATT

Controlling Electrical Machines

Introduction to the Dynamics of Automatic Regulating of Electrical Machines. By M. V. MEEROV. *Butterworths.* (100*s*)

The prospective reader should not be put off by the awkward title of this book, which in fact deals with the transient performance of automatically-controlled electrical machines. The author leads up to the analysis and synthesis of such systems by a systematic examination of the several individual aspects of the subject. Thus, there is an excellent section on the transient analysis of machines, including dc motors with variable field and variable armature voltage control, dc and synchronous ac generators and dc rotating amplifiers, the latter including an interesting table of standard Russian " amplidynes ". Further, the author includes a good survey of the mathematical background relating to Laplace transforms and related functions, though the section on amplifiers and transducers is by comparison inadequate.

The orthodox methods of analysis, such as the " Routh-Hurwitz " criterion, the " Nyquist locus " and " log magnitude-phase angle " methods are considered, as well as a number of other methods suggested by various Russian authors. The subject is well and clearly developed up to the complexity required for complete system analysis, and a number of points of special interest may be mentioned which, though not necessarily new or unique to the book in question, are of general importance.

In the course of the analysis of stabilization, several interesting suggestions are proposed for optimizing a system by means of the correct choice of negative feedback loop position. An attempt is made to define and classify the necessary and permissible simplifications and linearizations, which are essential to make an analytical treatment possible for practical examples. Here, of course, the reader will immediately be faced with the great difficulty inherent in the subject of presenting the characteristics of actual machines and control equipment in convenient and usable mathematical terms. (The use of computors, though mentioned, is not considered, and this would, of course, alter the method of approach very radically.) To another question of great practical importance, that of " quality " of performance of automatic control systems, no satisfactory practical answer is found, though there are a number of interesting theoretical approaches which would be worthwhile developing in more detail.

Considering still more difficult problems from the mathematical and analytical point of view, the author devotes considerable space to time-lag, non-linear and intermittent (or sampling) regulating systems. The latter are treated partly by the use of discrete Laplace transforms, which provide a convenient method of analysis.

Throughout the book, there is a number of worked examples of actual systems, mostly of the type of simple voltage or speed regulating problems and the like. There is an exception in the section dealing with time-lags, where the well-known problem of strip gauge control is discussed. These examples may be considered from the two complementary points of view of " theoretical " and " practical " engineers. For the former, there is adequate illustration of the principles involved in the mathematical analysis, but for the latter there is insufficient emphasis on the importance of overall design, as opposed to analysing a conglomeration of individual parts represented by the machine, the amplifier and, occasionally, the load, and making the system workable by suitable stabilizing circuits. The reviewer believes that this is a common fault in

many books on automatic control, as the emphasis normally lies on the automatic control section of the equipment, ignoring the possibilities and, in fact, the overriding importance of the electrical machine design and particularly the load, i.e. final product. For example, in the introduction the author mentions the use of multiple closed-loop control arrangements in modern high performance equipments, where there is often one control loop giving "compensation" and another giving "error-operation". The compensation part is entirely a function of the machine system, whilst the error-operation is entirely a function of the automatic control system. Similarly, the correct use of the measurement of the controlled variable, or its derivatives, is another aspect which requires emphasis when dealing with complete systems.

In view of the fact that the book is a translation, it should be stated at this stage that the subject matter is very well presented in a readable manner; the title is fortunately an exception to the general style. There are a few interposed comments of unnecessary emphasis on the importance of Russian effort in this subject, which, in a serious scientific work, tends to distract from, rather than confirm, the evidently large amount of work that has been done, as exemplified by the bibliography of over 100 references, substantially all of Russian origin (together with an additional list of 10 books in English). This, it must be pointed out, is both useful and to be expected; a similar book written in English would contain substantially only English language references, with probably a number of German references. There is an adequate index and, most important, a clear and detailed list of contents for quick and easy reference.

It is unfortunately true that the subject of automatic control is particularly beset with "jargon", which is both exasperating to the expert and bewildering to the general reader. The translator has, on the whole, acted very well by the reader, although some of the terminology is open to question, and in some cases appears to be an attempt at direct translation of the original, which results in terminology not in line with the generally accepted practice in the English literature.

A most interesting historical survey of the work done in Russia on the subject of automatic control is included and this forms a useful and helpful background for the English reader.

To summarize, there is no doubt that this book is well worth studying, both on its own account and to give a background to work which is not normally accessible to the general reader. It may, moreover, encourage someone to write the long-awaited treatise which combines a full, clear understanding of machines and their control systems and the true function of such combinations, and which will assist the user-engineer in appreciating fully the capabilities of modern high performance equipment.

K. K. SCHWARZ

Drawing an Essential Skill

Engineering-Technical Drafting and Graphics. By J. W. GIACHINO and HENRY J. BEUKEMA. *American Technical Society, Chicago; Technical Press, London.* (80*s*)

Training in mechanical engineering at university and other levels has been discussed frequently in recent years with comparisons of the methods used in other countries. Professor Burstall (*Proc. Instn. Mech. Engrs.*, vol. 171, no. 12 (1957), pp 463-8) quoted, "Generally the pursuit of engineering, unlike that of science, results in something being made—something that is useful though it may have other qualities such as elegance and economy," and he continued to emphasize the importance of design work in training by saying "I should like to see design work regarded by staff and students as the highest form of activity in which a mechanical engineer can engage, as it was regarded by Boulton and Watt."

Recognizing opposition to this view, however, he quoted the conclusion of an article on the training of designers by Mr. Ewen M'Ewen "The tendency nowadays is to try to produce a race of engineers who cannot draw, and to neglect the creative side so that the best men are drawn into other activities. If we are to survive we must not only pay attention to productivity but to the quality of what is produced; the designer is the key man."

From the introduction to the book it would appear that this aversion to the drawing board is not confined to this country. Writing it, a vice-president of General Motors Corporation says: "There is a tendency in present engineering education to minimize the importance of drafting," young engineers prefer experimental work rather than design as "they have been led to believe that work on the drawing board is of a menial nature, beneath the dignity of a graduate engineer." With an excellent plea for "men of vision able to draw, check, follow parts through to assembly and test, all round engineers," he concludes that drafting is an important engineering tool.

The investigations of a productivity team recently showed that a typical American undergraduate course gave engineering drawing and design subjects prominence in three out of the four years' course (Mishra, R., "Education for Industrial Engineering," *Production Engr.*, vol. 40, no. 6, June 1961, pp 371-8). It would appear that the book has been prepared for use in such training of "all round engineers" in their university careers, but the subject matter is so varied that it might be regarded as a symposium for drawing office executives, or a draughtsman's guide from school to anywhere.

It is a first edition and is a comprehensive volume of 778 pages in 27 chapters. The wisdom of including chapters on architectural drafting, plumbing, heating and electrical drawing, map drawing and graphs and charts, in a book on engineering and technical drafting is debatable. The order of the chapters is also surprising. For example, the chapters on descriptive geometry and developments (21, 22) would more suitably follow the work of chapters 4-6 on geometrical constructions, projection and dimensioning. Furthermore to follow this chapter on dimensioning by one entitled precision dimensioning is a surprise, but in fact this chapter is a fairly full discussion of tolerance systems.

There is an excessive elaboration of detail in the profuse diagrams, for example, six diagrams and descriptions to show how to draw a line parallel to another through a given point, diagrams and discussion to show the direction in which the pencil should move on a "triangle" (setsquare), and diagrams to show the order of drawing the lines on an arrowhead. In a chapter on "Fasteners", nails, tacks, woodscrews, as well as springs are all fully illustrated and described, besides the more usual work on screws, nuts and keys.

The introduction to orthographic projection is very hazy. As would be expected, third angle is used throughout, but the meaning or veracity of the statement "First angle projection is the system used exclusively in European countries" might be questioned. (Why mention second and fourth angle?). It is surprising after this introduction to find the views described as top view, bottom view, etc. Plan and elevation are not used except in a much more practical chapter on tool drawing. From extreme detail of description, the text passes to a section in which a complete range of manufacturing processes from foundry and forge to machine shop operations, including lapping and honing, is described in a sketchy manner with poor diagrams.

There is a highly controversial chapter (Simplified Drafting) describing methods whereby drawing office time could be saved by such methods as omitting arrowheads on dimension lines, omitting views, using descriptions instead of views, etc. Examples of conventional and such simplified drawings are compared. Within a strictly limited field of circulation drawings could be made thus and some time be saved, but the dangers of the practice are very real.

The 36 pages of appendix and index includes a number of ASA standards, but no bibliography. In view of the spread of material in certain chapters, reference to other works on manufacturing processes, tolerance systems, patent law, architecture, etc., should have been given. With such variety of subject matter the book does not meet any particular need in this country though it would perhaps be of interest in the library of large organizations for reference, or to permit different groups to discuss the controversial chapter.

C. J. ATKINS

Progress by Discussion

The Stagnant Society. By MICHAEL SHANKS. *Penguin Books.* (3*s* 6*d*)

The possibility that Great Britain may join the Common Market has let loose agonizing reappraisals in industry and commerce. Any busy executive, anxious to put himself rapidly abreast of the current ferment in ideas, could hardly do better than read Mr. Shanks's simply written but authoritative survey of virtually every leading political, social, and economic headache of the day. Mr. Shanks is, of course, concerned with the major problems of high costs, low productivity, and creeping inflation, which have made Britain one of the world's slowest growing economies, but he also analyses such matters as the economic repercussions of the class divisions which impede understanding between employers and workers, the neglect of technological education, and the degree to which excessive protection has undermined efficiency and the competitive spirit.

Mr. Shanks is a Fabian socialist, but he does not hesitate constructively to criticize the archaic organization and obsolete 19th Century economic thinking of the trade unions, which he calls "the greatest institutional barrier" to the emergence of a dynamic economy. He would extend the power of the unions, not limit it.

There is current a widespread idea that a trade union leader should be a sort of *ex-officio* Civil Servant, responsible to the community rather than to the workers. His job is regarded as "knocking sense" into the workers, restraining them from big wage claims and strikes, and encouraging them to increase their productivity. This is exactly the role that a union leader plays in the USSR, and Mr. Shanks rightly insists that

any leader who acted thus in a democracy would lose his job.

Mr. Shanks urges that if the trade unions are to moderate their demands to a level which the economy can afford, they must be given an inducement. The TUC Council should be given an equal footing with the British Employers Confederation to join with government representatives in a planning commission for industry, under the chairmanship of the Chancellor of the Exchequer, which would keep all economic policies under review, establish wage planning and a national wages policy. For this to be effective a prior reform would be essential. Mr. Shanks considers that the TUC constitutes a second rate bureaucracy because its officials are overworked and underpaid. Many earn less than their fellow members on the factory floor. But the unions ought to pay the wage for the job, and they can afford to. For example, in 1912, union dues in the AEU were 1*s* 9*d* a week when wages were 38*s*. In 1959, earnings averaged £14 a week while dues were 2*s* 3*d*, that is, they had fallen from over 4 per cent of earnings to less than 1 per cent. The result is that union officials tend to be recruited from mediocrities, while able men go elsewhere.

The unions should reflect over the American system of "Business Unionism," in which members pay dues commensurate with their earnings. This enables salaries to be paid which attract union leaders of a calibre equal to the employers or government officials with whom they negotiate. An American union leader like Walter Reuther does not approach his task handicapped by 19th Century feelings of proletarian inferiority, but as a 20th Century business leader, whose job is to ensure that a company uses the latest technologies to maximize its profits in order that it can pay maximum wages within the productivity available. American unions are not afraid of dismissals to promote greater productivity, providing those remaining in employment get bigger pay packets.

The Conservative Government is by no means the only one to have appealed constantly for wage restraint without offering anything in return. But, asks Mr. Shanks, why should wages be the one planned element in an unplanned economy? He consoles any timid employer, nervous of planning, with the thought that if we are to have a planned economy it would be equally impossible to leave wages as the one unplanned element.

A planning commission's first job would be to draw up an annual forecast of the nation's economic prospects, estimating how much extra purchasing power could safely be released, whether as higher wages or as improved welfare services. The planners would also have to ensure that enough money was going to industrial investment, and that the balance of payments was not jeopardized. Mr. Shanks is careful to explain that he does not favour the kind of planning in which a group of Olympian bureaucrats, or party leaders, lay down production targets in what *they* conceive to be the national interest, taking no account of the need to produce what *consumers* want. He envisages a flexible system, comparable to that existing in France, of voluntary cooperation between the government, industry, and the unions, which would allow the price mechanism to work and would assume that competition is essential to progress. The French experience suggests that the recommendations of such a planning group are likely to be based on compromises worked out by men who feel themselves engaged in a common enterprise, and who also realize that unforeseen factors may crop up which will modify their next round of negotiations and of planning.

The basis of Mr. Shanks's scheme is that agreement would come from the recognition by high calibre union leaders that, at some point, the interests of the workers would be better served by advances in, say, the expansion of an industry, the introduction of new techniques, or improved welfare services, than by forcing wages up to a level at which they would be offset by higher prices or unemployment. Union leaders are not fools. Most already understand how self-defeating are the demands for increased wages to which their members annually commit them, and they would be glad to "give a sensible lead"—provided that they could demonstrate factually to their members that they would benefit from it.

Such a planning commission would calculate, and publish, how great an increase in wages could be afforded. There is no doubt that many companies would gladly pay higher wages today, if only they were certain that the unions and the workers would cooperate to ensure that the higher wages were earned. A major task for the TUC, in Mr. Shanks's view, would be to persuade the workers to agree to shift working (the lack of which seriously deters capital investment), the elimination of restrictive practices, and the adoption of work study methods.

It would be idle to suppose that Mr. Shanks's system could be evolved quickly, or that it would always work painlessly. Mutual trust could only come gradually, from the habit of working together. Mr. Shanks concedes that, in some years, the planning commission might be unable to agree on wage recommendations. He points out that the government would then have to make its own allocations, and resolutely face the consequences, since it is clear that, where full employment exists, no government can remain neutral in a struggle for higher wages, which, by pushing up the internal price level, may undermine Britain's ability to compete in world markets, and so induce a balance of payments crisis. But if the government were to set up a planning commission, and to give it full support when it produced agreed recommendations, persistence might well be rewarded. One of the greatest by-products would be to soften the rigours of the class struggle by demonstrating to the different groups in the community that each had gained more by cooperation than by conflict.

JOSSLEYN HENNESSY

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electrical Equipment

Malfunction Detector. ELECTRO METHODS LTD., Caxton Way, Stevenage, Herts. Technical Bulletin RF6166, a folder describing the Vibraswitch, a vibration sensitive device to protect rotating and reciprocating machinery from damage resulting from defects which give rise to vibration. Illustrated.

Nuclear Instrumentation. NUCLEAR-CHICAGO CORPORATION, 333 East Howard Avenue, Des Plaines, Illinois. A general catalogue on nuclear instrumentation. Over 250 nuclear instruments are described; more than half of these, counting systems, and accessories, are stated to be new. 96 pp., illustrated.

Electronic Equipment. BRUCE PEEBLES AND CO. LTD., Edinburgh 5. Leaflets relating to a resistance-network analogue, resistivity meter, electronic sequence timer, sediment detetector, M-scope water-level indicators, and a C-scope for instrumentation and research apalications in the chemical and allied fields. All illustrated.

Oscilloscope. EMI ELECTRONICS LTD., Instrument Division, Hayes, Middlesex. A leaflet giving particulars and technical specification of the Type WM16 oscilloscope. This is a wide-band unit which has a range of plug-in pre-amplifiers providing differential, high gain and dual trace input facilities as well as the normal 40 Mc/s wide-band input. 8 pp., illustrated.

Neon Indicator Units. WALMORE ELECTRONICS LTD., 11 Betterton Street, Drury Lane, London WC2. A folder on SGF and SGFF indicator lamps designed to operate on ac supply lines. Lamp, resistor, and holder are combined in one packaged unit. Illustrated.

Torque Tester. EMO INSTRUMENTATION LTD., Western Road, Bracknell, Berks. A leaflet describing a friction testing machine for determining the starting or breakaway torque of precison ball bearings. Illustrated.

New Books

Principles of Vacuum Engineering. By M. PIRANI and J. YARWOOD. *Chapman and Hall.* (£5 5*s*)

This should appeal to a wide readership—from the final-year student, through post-graduate research worker, to the practising scientist and engineer. Throughout, the emphasis is on the practical facets of the subject, and in keeping with this approach the text is generously leavened with good line drawings. The bibliography runs to over 500 entries.

Engineering Materials Science. By CEDRIC W. RICHARDS. *Wadsworth Publishing Company, San Francisco; Chapman and Hall, London.* (60*s*)

Essentially an elementary exposition of solid-state mechanics and physics, this is intended to prepare the engineering student to make the most effective use of the materials at his disposal. The pattern followed is first to discusss the general and then the specialized aspects of materials and their applications. Experimental methods of investigating mechanical properties are fairly well covered.

Technical Glasses. By M. B. VOLF. *SNTL—Publishers of Technical Literature, Prague; Pitman, London.* (42*s*)

The physical and chemical properties are presented of more than 850 glasses used universally in laboratory apparatus, industrial plant, electronics and medical equipment. The special optical glasses are not included.

Frame Analysis. By ARTHUR S. HALL and RONALD W. WOODHEAD. *Wiley, New York and London.* (68*s*)

The principles of both stiffness and flexibility analysis are applied to investigate the behaviour of the general frame whose load displacement relationship is linear. Three-dimensional frames containing curved members and members of varying sections are considered in detail. Matrix algebra (the elements of which are introduced in an appendix) is used extensively.

The Reviewers

Mr. R. M. Dannatt, M.A., B.Sc., is a project engineer with Chemical Construction (GB) Limited. He is an A.R.I.C. and A.M.I.Chem.E.

Mr. K. K. Schwarz, M.A., is personal assistant to the technical director of Laurence, Scott and Electromotors Limited. He is an A.M.I.E.E., M.I.S.I. and M.S.I.T.

Mr. C. J. Atkins, A.M.I.Mech.E., A.M.I.Prod.E., A.M.B.I.M., is senior lecturer in engineering at the Croydon Technical College.

Mr. Jossleyn Hennessy, M.A., is an economist, broadcast commentator and London editor of the *Eastern Economist*, New Delhi. He was formerly director of public relations to the Government of India.

Analysis of Statically-Indeterminate Frameworks. By T. M. CHARLTON. *Longmans.* (30*s*)

This is an elementary course in the subject (excluding the stability aspect), developed logically in accordance with current trends in frame analysis: stiffness and flexibility coefficients; elastic centre concept; virtual work concept in deflection determinations; energy principles; and the reciprocal theorem. A chapter of 25 exercises and a bibliography of 21 items conclude the book.

Moment Distribution: A Rapid Method of Analysis for Rigid-Jointed Structures. By EDGAR LIGHTFOOT. *Spon.* (67*s* 6*d*)

Meeting the needs of practising engineers and of degree and post-graduate students, this comprehensive exposition covers both the well-established basic theory of moments distribution and the recently-devised procedures for the rapid analysis of frames by the familiar elastic method. Numerous worked examples and specially prepared tables and line drawings illustrate the application of the methods to many different types of structure.

Marketing

Pakistan Orders More Earthmoving Equipment

NCK-RAPIER LIMITED have received an order worth over £260,000 from the East Pakistan Water and Power Development Authority for 15 crawler-mounted draglines and three truck-mounted cranes. The money for the purchase has been raised through a UK loan to the East Pakistan Government.

The machines are to be made at the Thornecliffe, Sheffield, works of NEWTON CHAMBERS AND COMPANY LIMITED and will be fitted with CATERPILLAR engines. The draglines will comprise five of the 605 type with a capacity of 1½ cu. yd and ten 304's of ¾ cu. yd capacity. The cranes will also be of the 304 type having a lifting capacity of 25 tons.

NCK-Rapier, who are the selling organization for excavators and cranes made by Newton Chambers and RANSOMES AND RAPIER LIMITED of Ipswich, both members of the Newton Chambers Group, have previously been successful in West Pakistan. At the beginning of the year, eight 605 draglines were sent there for work on the Punjab fertilization projects.

Distributors for the machines in Pakistan are the International Farm and Earthmoving Equipment Company of Karachi and Dacca.

Export Possibilities for Building Materials

A conference held recently at Olympia considered the potential of the export market for building materials. Organized by the Ministry of Works in conjunction with the building exhibition, it was attended by about 200 representatives of the building industry and the speakers included Lord John Hope, M.P., Minister of Works, in the chair, and Sir Keith Joseph, Bt., M.P., Minister of State, Board of Trade.

Lord Hope, stressing the importance of increasing exports as a measure towards enabling the Chancellor to relax his restrictive measures, spoke of a market which is very much alive. The present annual level of exports is around £85 million, almost one-tenth of total output, but the area intensity varied as old-established markets narrowed and new ones were opened up.

An example of this was a drop in Commonwealth exports which was offset by a sharp upward trend in the Middle East and Western Europe. He urged firms in the industry, who were not at present exporting, to give the matter serious consideration as, while condoning the feeling that exports were incidental to the home market, he believed that those with firmly established markets at home could reap rich rewards abroad. Some basic materials were bulky and costly to transport, but such commodities as sealing and waterproofing compounds, and finishing materials, were of greater intrinsic value and would sell in distant markets, where they were less readily available. Quality of design, prompt delivery and a competitive price were the main provisos.

Mr. E. R. G. Corn, speaking of ceramics, an industry exporting more than most and importing virtually nothing, supported Lord Hope's desire to explore new markets. But he criticized the Government's failure to provide concrete incentives and a policy which left export exploitation to the manufacturers' sense of altriusm and patriotism.

Mr. B. G. Donald outlined the role of the export merchant and the work undertaken by export organizations in dealing with preliminaries. He was followed by Mr. E. A. Midgley, HM commercial counsellor at The Hague, whose theme was the potential of the European market which he described as "rich, sophisticated and exciting."

Sir Keith Joseph said that profits and patriotism go hand in hand, and the more emphasis a firm placed on an export policy, the more money it would find in it. In addition he believed that exports might in some cases greatly assist home overheads. He took up a remark by Mr. Corn that overseas tariffs were coming down and qualified this by saying that UK tariffs were doing likewise, independent of entry into the Common Market.

Sir Keith went on to outline the supporting role played by the Board of Trade and ended by echoing Mr. Midgley: "Those rich, highly sophisticated markets are eager for British goods and they lie no further away than Wales or Scotland."

BAC Sells Viscounts to China

The first order from China for Western aircraft has been received by the BRITISH AIRCRAFT CORPORATION. The order from the Chinese Government is for Vickers Viscounts powered by Rolls-Royce Dart prop-jet engines and includes substantial quantities of spares and electronic equipment.

A cloak of secrecy has surrounded the negotiations, at the customer's request, but the Viscounts will be used for internal and overseas routes and about six aircraft are believed to be involved. Delivery is scheduled to take place within the next 18 months and BAC, looking on this as a trial batch, are optimistic about further orders to follow if the aircraft prove successful.

Viscounts are already in service in other parts of the Far East having been bought by Indian, Japanese and Philippine airlines.

Folly to Neglect the Eastern Bloc

The 10 per cent increase in exports, equivalent to about £350 million, called for by the Governor of the Bank of England, could be found in the planned economy countries according to Lord Boyd Orr. This statement was made during his presidential report at the annual general meeting of the British Council for the Promotion of International Trade held in London on 7 December.

Radical changes of policy would be required, however, on the part of the Government, and a complete reversal of some of the practices of Government Departments. Exports to these areas were increasing at a higher rate than to any other part of the world but the Government was curbing further expansion with a policy of "measured development."

He called for a liberalization of import restrictions for the planned-economy countries similar to that which has been adopted for other areas. "We are losing markets," he stated, "primarily because of a refusal to recognize that the pattern of our imports from the East must match the wider scope of our exports. We readily buy similar goods from other countries not in the least anxious to import more from us."

Of Britain's imminent entry into the Common Market, he felt that this would bring no immediate solution to economic problems and there was no excuse to relax efforts in the Eastern Bloc when European competitors were increasing theirs. He emphasized that Britain's standing within the Six would increase with the minimum dependence on Common Market trade.

He referred to the Eastern Bloc as the most rapidly expanding market in the world. To neglect it would be to lay up greater trouble in the future than is apparent in current trade figures.

Mr. Leonard H. Short, chairman of the BEAMA Export Panel, presents a copy of the association's new Directory and Buyers' Guide to Sir Keith Joseph, Minister of State, Board of Trade. This handbook, which incorporates a five-language section, will be distributed to 15,000 overseas buyers of electrical and allied equipment.

Radar System Goes to Yugoslavia

COSSOR RADAR AND ELECTRONICS LIMITED have sent a complete airfield radar surveillance system to the new airport at Belgrade, Yugoslavia.

The complete equipment, weighing 10 tons, is known as the CR787 and was developed as a private venture. Similar units have already been supplied to civil and defence aviation authorities in Britain, Europe and the Commonwealth.

The aerial head will be erected on top of an air traffic control tower 120 ft high at Surcim Airport, 10 miles from Belgrade. Commission of the project is scheduled for the beginning of February and two Cossor engineers have been engaged to supervise the installation.

The system is a duplicated S-band radar (10 cm) and incorporates devices for the elimination of echoes from fixed objects such as mountains and buildings and the achievement of a high degree of discrimination against rain. These techniques keep the radar display clear for signals of moving aircraft and their development has been largely the work of Cossor.

Switchgear for West Thurrock

A further contract valued at £230,000 has been awarded to SOUTH WALES SWITCHGEAR LIMITED of Blackwood, Monmouthshire, in connection with the West Thurrock power station.

The company is at present manufacturing and installing the low voltage auxiliary switchboards at West Thurrock. This latest order from the Southern Project Group of the Central Electricity Generating Board for 35 similar switchboards for auxiliaries on generator sets 3, 4 and 5 will bring the total of SWS equipment incorporated in the project to about £500,000.

De Havilland Extend Fluid Engineering Service

The DE HAVILLAND AIRCRAFT COMPANY LIMITED has progressed a stage further towards the provision of a complete fluid engineering service. The company has concluded an agreement with the F. H. MALONEY COMPANY of Houston, Texas, whereby its Commercial Products Group will manufacture and market Malony designed uni-directional and bi-directional meter provers.

Based on a design concept of the Shell Development Company of the USA, the meter permits calibration of flowmeters *in situ*. The technique utilizes a flexible sphere which is inserted in a permanently installed loop of pipeline whose internal surface is finished to close tolerances. Special entry and exit ports facilitate ready insertion and removal of the sphere and the rate of flow is calculated from the electronically measured time taken for its traverse along a known distance of the prepared section.

Advantages claimed for this method are extreme accuracy unaffected by variations in viscosity and no interruption of oil flow when the flowmeters require checking.

The de Havilland meter provers, which are suitable for use with any type of flowmeter, will be marketed throughout the world except in the North American continent.

The Yorkshire "Janus" Diesel Electric Shunting Locomotive

An industry going through changing times can hardly be expected to produce an above-averagely successful candidate eligible for Product Profile analysis. One company at least can claim to have done so.

THE Janus diesel shunter was born during a transition period in the Yorkshire Engine Company's history. They were not one of the first British locomotive builders to change from steam to diesel, but nor were they among the last. When the change was embarked upon soon after 1950, it was gradual but decisive.

The locomotive industry has had to face not only the disappearance of old steam markets, so suddenly that some products of the last ten years have already been consigned to the scrap heap; but also, being traditionally dependent on exports, the tremendous difficulties that now beset any company in obtaining overseas locomotive orders.

It is the all-too-familiar story of comparative British prices, and increasingly unfavourable tariff restrictions, coupled in this case with the different nature of the equipment used for diesel and electric traction that has brought many new firms into the picture, hitherto unassociated with railways and their rolling stock.

Moreover, the locomotive industry has not for many years enjoyed more than a share in the building of main-line locomotives for the home railways, and British Railways still naturally prefer to keep their own shops employed to some extent on such work. In a sense Yorkshire are fortunate in having concentrated for many years mainly on shunting and industrial locomotives—but even so, overseas orders have always been more instrumental than home requirements in determining the company's fortune.

Yorkshire Engine Company is at Wincobank on the outskirts of Sheffield and employs about 450 all told. Most of the factory premises dates from the founding in 1865. The company have always been concerned primarily with building locomotives, though at various times they have had other important interests. In the early days they played an important part in developing certain overseas railways, particularly in India. Russia, Turkey, Australia and New Zealand also bought locomotives in some numbers. There is a strong tradition in the company for being experimental and original—for instance, they built the first locomotive in this country to have Walschaerts valve gear, and they played a part in the development of the Fairlie articulated locomotive.

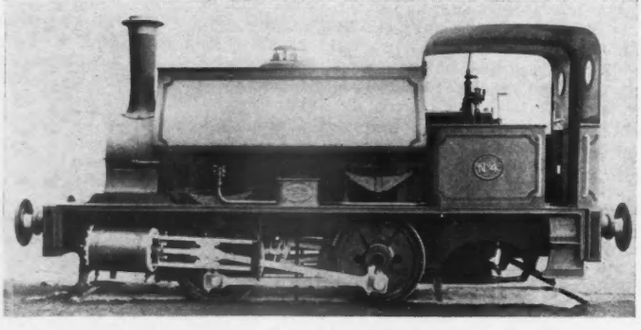
Industrial locomotives figured prominently in the order book before the turn of the century; and from 1914 onwards they predominated, despite periodic spasms of main-line locomotive building. During the lean period of the 1930's the works were kept going with locomotive repair work and general engineering.

During the Second World War, the company were occupied with munitions and built no locomotives. This situation impressed the management with the fact that well-equipped heavy fabrication, forging and machine shops were tremendously useful assets outside the manufacture of locomotives. So it was that diversification of interests became a permanent policy, which has enormously assisted the company during the steam-diesel changeover period. Today about 45 per cent of their manufacturing facilities are engaged in a variety of other directions such as steelmaking and mining equipment; all without prejudice to their established repair work on locomotives and boilers.

How is a relatively small company expected to react when faced with a build-up of seemingly impossible odds against continuing in their traditional line of business? They could of course elect to leave the business altogether and concentrate on their other interests—a particularly tempting course when the latter are already established. But the Yorkshire Engine Company succeeded in establishing a particularly healthy reputation among locomotive users over the years of which they are justly proud. In the words of the present technical director, Mr. J. N. Compton, when interviewed by ENGINEERING, "We like to think of ourselves as locomotive builders—and we intend to remain locomotive builders."

The changes imposed on the locomotive manufacturer in going over from steam to diesel production go far deeper than the difference in crafts employed. Buying the engines and transmission from outside brings a big reduction in the occupation of the machine shop capacity, which dovetails in ideally with Yorkshire's diversification policy. The locomotive builder is left with little more than making the frames, wheels and axles, assembling the locomotive and connecting up the pipes and cables.

Fig. 1 Typical Yorkshire industrial steam locomotive of 1905.



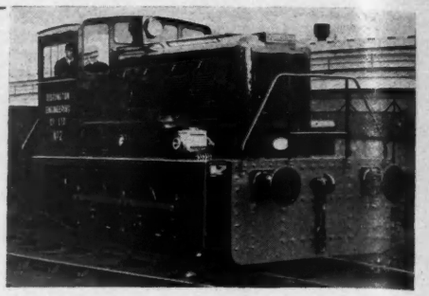
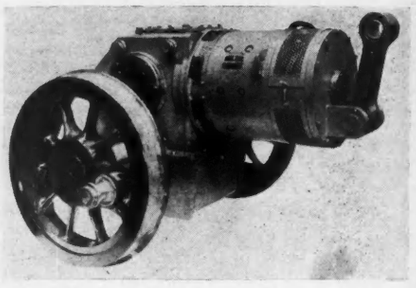


Fig. 2 (above) 200 hp diesel electric shunter of 1955.

Fig. 3 (below) Janus' traction unit, interchangeable with the 220 hp locomotive type.



To look at the problem from another angle, the shop capacity that used to be kept fully employed in turning out about 18 steam locomotives per year requires about 40 diesels and they only fill some departments; and yet when a locomotive user changes to diesel, he can generally expect to require fewer locomotives to do the work of his steam fleet due to the diesels' higher traffic availability. No wonder the locomotive industry is being forced to reduce its size and proportion itself to drastically altered market conditions.

The effect of putting the engine and transmission into the hands of specialist manufacturers is to spread locomotive manufacture over a broader section of the engineering industry, possibly to the detriment of some established locomotive builders. Yorkshire have taken advantage of the situation by choosing famous names for their sub-suppliers, in keeping with their own established reputation for quality. Rolls-Royce six or eight cylinder diesel engines are wedded to electrical equipment developed specially by AEI. For the customer who prefers the larger medium speed diesel, Paxman engines are fitted to certain locomotives; and the company's range has recently been further broadened by the introduction of diesel hydraulic locomotives using a 3-stage torque converter.

In steam days the company built locomotives to their own design, to the design of the customer, or to a design undertaken jointly. In order to enter the diesel market new tactics were required. With the aid of the United Steel Companies (into whose group the company was merged in 1945) two prototypes were constructed in

LEADING PARTICULARS OF JANUS

Locomotive weight	48 tons
Maximum tractive effort	32,000 lb
Maximum permissible speed	23 mph
Supercharged oil engines	Rolls-Royce C6SFL
Total installed diesel engine rating at 1,800 rpm	466 hp
Horsepower available for traction at 1,800 rpm	440 hp
Generators	AEI Type RTB6032
Traction motors	AEI Type RTA5041
Gear ratio	22·85 : 1
Track gauges	4 ft 8½ in, 5 ft 3 in or 5 ft 6 in
Number of driving positions	Four
Can negotiate curves	120 ft radius
Type of axlebox	Plain leaded phosphor bronze or roller bearings
Brake equipment	Westinghouse straight air brake fed by Rolls-Royce compressors mounted on engines
Fuel tank capacity	400 gall.

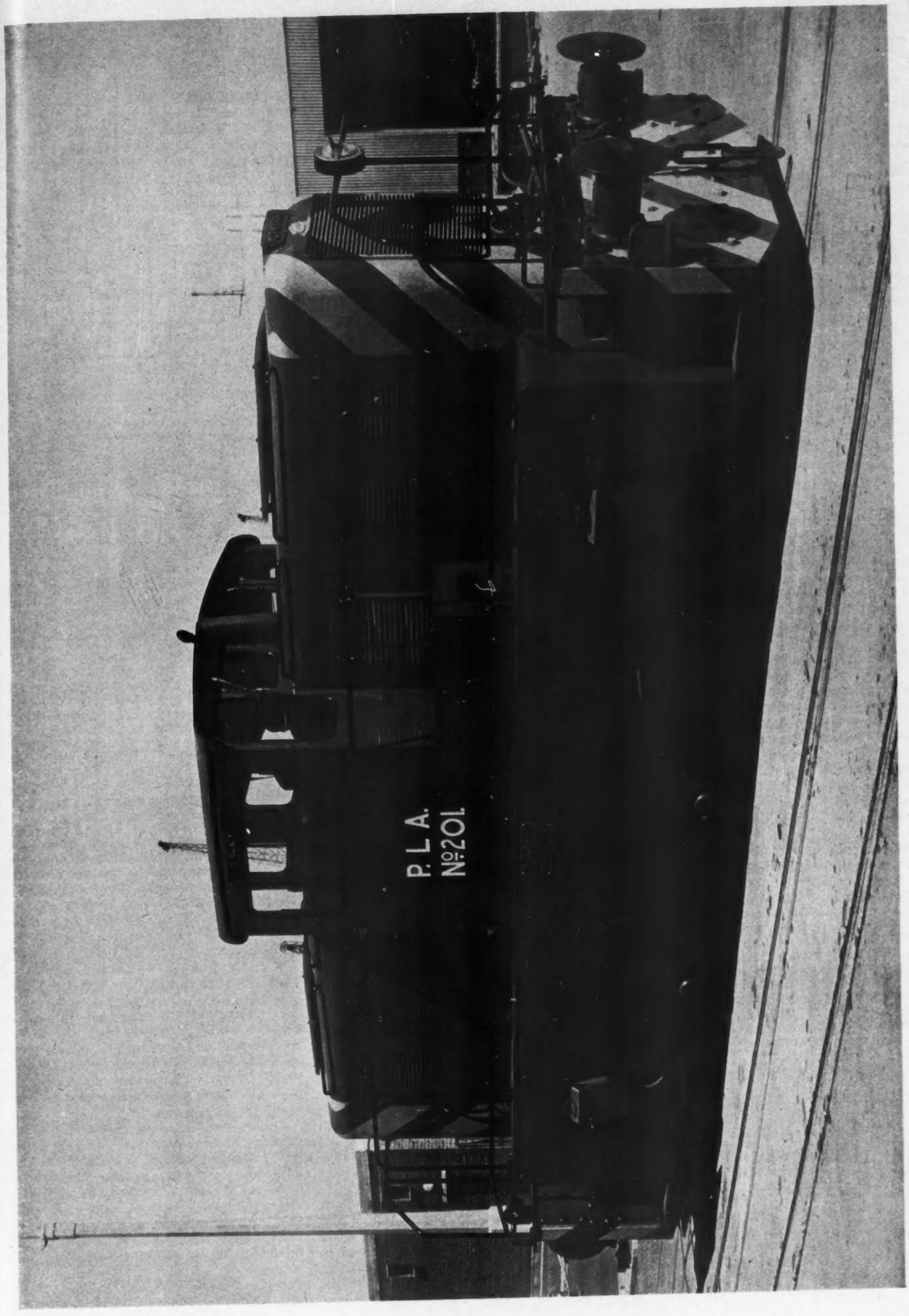


Fig. 4 The product of bringing together three famous names in specialist branches of engineering.

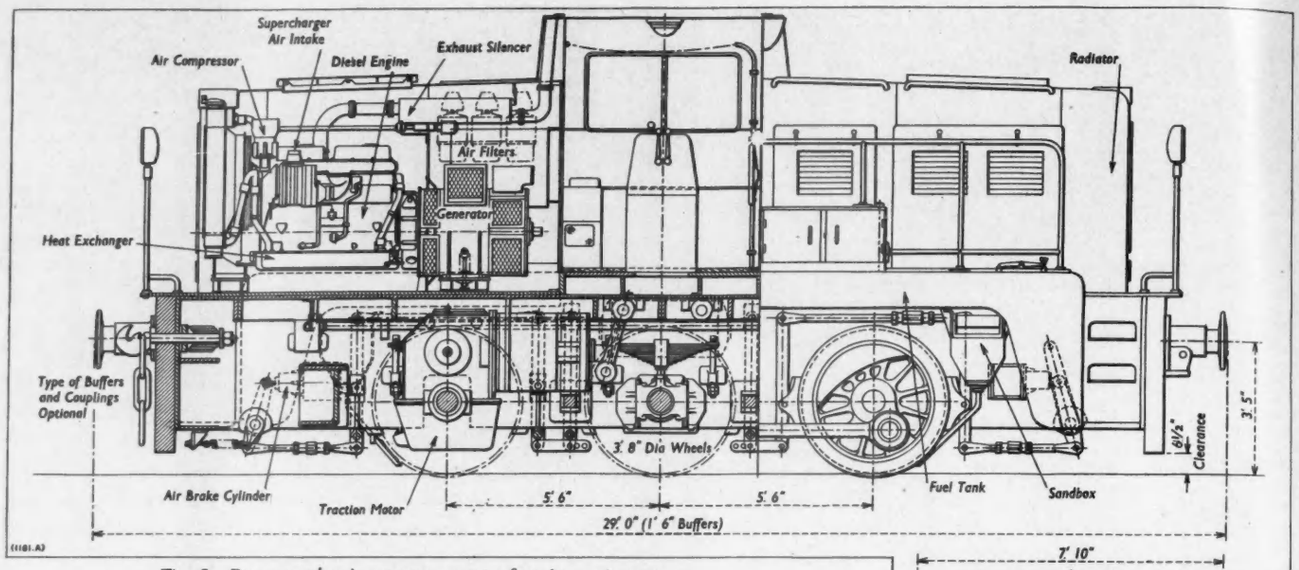


Fig. 5 Drawing showing arrangement of main equipment.

1950, using 275 hp Paxman engines, as diesel electric shunting locomotives suitable for a four or six coupled chassis and having certain optional features to customer choice. The success of the range of low powered shunters which followed led the company to introduce the 400 hp Janus, based on twin 200 hp power units, in 1956. The engine rating was later increased 10 per cent.

Janus (named after the two-headed god) at once caused eyebrow raising in railway circles. The main departure from previous British practice was the division of the power unit into two identical power packs, with a pair of traction motors mounted one on each outer axle, with the cab central. Apart from the obvious advantage of interchangeability with the 200 hp locomotives, the chief virtue of this arrangement lies in the driver's look-out, so vital for shunting duties. By retaining the same compact bonnet contour, the look-out is equal to that of the 200 hp machine. One has only to look at the outline of the single engined type of shunters of about the same horsepower, first designed in the 1930's, to appreciate that look-out from a diesel can be worse than from a steam locomotive. The cost of incorporating twin high speed units is actually no higher than that of one larger lower speed engine.

The framing is of the rigid plate type, the side plates being placed inside the wheels with fabricated stretchers and all bolted together. Buffer beams 6 in thick are bolted to each end and brought down to 6½ in from rail level in order to protect the gearboxes in the event of derailment. When building a steam locomotive, the designer's aim is usually to save weight wherever possible in order to keep down the axle loading. With a diesel shunting locomotive the reverse is normally the case, as with no boiler and its water the framing material must be increased in order to provide adequate weight for adhesion.

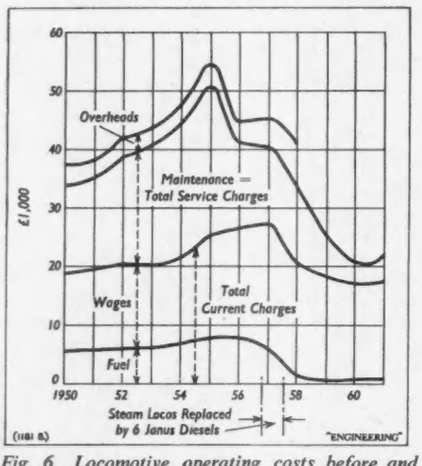
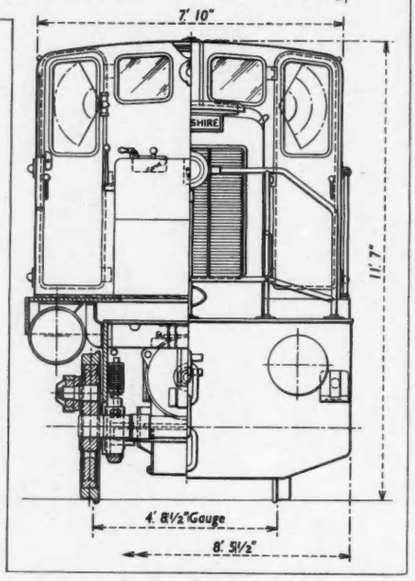


Fig. 6 Locomotive operating costs before and after changeover to Janus diesels at Tilbury Docks. The locomotive allocation was subsequently modified.

The power unit is resiliently mounted on the frame which embodies a continuous deck to protect the traction motors from oil and water. The traction motors are axlehung and free to float in any direction with a flexible nose suspension to absorb shock through the gears. An important feature introduced to this country by Yorkshire and since copied is the provision of "step-ins," or recessed platforms, at both ends of the locomotive for the shunters. The side platforms are formed by four generously sized fuel tanks which contribute to accessibility.

A Product Profile is not the place to reopen the various arguments that have taken place in recent years for and against British Railways main line dieselization programme. Suffice it to say that for shunting duties the economics of diesel operations are unchallengable. In Britain it is generally accepted that a 75 per cent saving in fuel alone will result from a changeover from steam shunting, which is all in favour of the industrial diesel locomotive. Yorkshire Engine Company are wisely taking active steps to broaden their range, and now have 12 types of diesel-electric or diesel-hydraulic locomotive on the market with horsepowers ranging between 170 hp and 600 hp. The only serious challenge to the industrial diesel is the replacement of the rail system by road haulage vehicles, which is a tendency with some of the smaller concerns.

To emphasize the economics aspect of steam versus diesel shunting, Fig. 6 shows a chart kindly supplied by the Port of London Authority, showing costs before and after changeover from steam to Janus shunters at Tilbury Docks. The Authority was one of the earliest users of Janus and now have ten of them running, as well as 220 hp and 300 hp Yorkshire locomotives. All these locomotives have given every satisfaction, and the overhaul life of 9,000 engine



service hours quoted by Rolls-Royce offers every prospect of being handsomely exceeded.

A virtue of the PLA's locomotive policy is the standardization of spares for the three types. The Janus and 220 hp locomotives have identical engines and drives, and the single eight-cylinder engine in the 300 hp locomotive possesses many parts in common with the six-cylinder engine. The PLA's choice of locomotive supplier was based on a specification they issued to various builders.

Of a total of 200 diesel locomotives constructed during the past ten years, 65 of them have been of the Janus type. They have proved especially popular for the heavy duties in steelworks. Roughly 25 per cent of the company's locomotives have gone to users within the United Steel Companies group.

Despite steadily rising cost in labour and materials, the company have managed to keep their prices fairly steady, at a time when steam locomotive costs are increasing rapidly. Their latest development is a 600 hp diesel-hydraulic locomotive which has an eight-wheel chassis and is constructed on a similar principle to Janus, using two engines. This type can also be offered with electric transmission up to 700 hp.

Yorkshire Engine Company Limited, Meadow Hall Works, Sheffield 9.

"Arc Welding" Theory of Cosmic Evolution

Theories on the formation of the universe are many and varied. One which has arisen from studies of mundane phenomena such as arc welding has much in its favour.

By C. E. R. Bruce, M.A., D.Sc., M.I.E.E., F.Inst.P.

DURING the last twenty years the writer has considered the evolution of the universe and the phenomena presented by atmospheric astrophysics—as opposed to the nuclear regions of stars, for example—from a new point of view, which depends on the introduction of a new major variable, the electric field, into the subject. As even astrophysicists themselves do not seem to be aware of the shortcomings of their theories, having become so used to ignoring them, it may be better to mention a few of the major difficulties experienced by existing theories right at the outset. They have, for example, no clue to offer as to the nature of intergalactic forces *more than 100 times those exerted by gravitation*—as evidenced, for example, by the effect of the neighbouring Magellanic Clouds on the shape of our own galaxy; they have no clue to offer as to the origin of the magnetic fields and very high speed, or relativistic, electrons postulated to account for cosmic radio-noise; nor as to the origin of those cosmic gas jets, which for the last 60 odd years have been postulated as the cause of magnetic storms; nor as to the origin of the highly excited atoms—up to temperatures of the order of a million degrees—which suddenly appear in atmospheres at temperatures probably well below 1,500°K. So the writer, in offering a general solution for all these and many other existing difficulties, cannot be accused of "teaching his grandmother how to suck eggs," for such things as magnetic fields, relativistic electrons, cosmic gas jets, etc., do not " grow on cosmic gooseberry bushes," so to speak.

However, with the introduction of an electric field-building process, very similar to that with which we have become familiar during the last 200 years of investigations on terrestrial thunderclouds, the situation is very different, and those of " Nature's laws " which have remained " hid in night," despite Pope's description of the clarification effected by Newton's introduction of gravitation, are themselves considerably illuminated. It may be pointed out here that, despite the said 200 years of investigations on terrestrial thunderclouds, the conditions therein are still shrouded in partial mystery, so we cannot expect to deal adequately with the electric field-building processes in the atmospheres of stars and galaxies. The last mentioned are collections of the order of 10^{10} to 10^{11} stars and the atmospheres of gas and dust in which they are embedded—the spiral and globular extra-galactic nebulae.

The theory is divided into four parts:—

(1) The process of electric field-building in cosmic atmospheres;

(2) The breakdown of these fields in electrical discharges;

(3) The process of aggregation or concentration of the atmospheric matter along the discharge channels by magnetic pinch effect, an effect to which, as we shall see, we owe the process of arc welding. When this effect operates, gravitation has a quite negligible effect.

(4) Deriving from the previous process are the cosmic gas jets, which account, for example, for magnetic storms, and for those extensive stellar atmospheres which surround most stars, and in some extend to dimensions of the order of those of our whole planetary system.

Cosmic Atmospheric Electric Fields

The clue to the origin of these cosmic atmospheric electric fields is probably supplied by the little-known investigations of a Professor of Physics at Nottingham University—Professor P. E. Shaw—in the mid-nineteen twenties. He showed that in order to charge two pieces of matter by friction or impact it is not necessary that the pieces should be of different materials. If there is asymmetry in the inter-action the two pieces may be oppositely charged. Such interactions obviously occur in wind-blown dusts, and Shaw showed that the particles become charged under such conditions, and that the effect is of the same order with dry ice particles as with sand. Two observations which seem to the writer of first importance in this connection are that electric fields are built up to breakdown in terrestrial sand and dust storms, and in the ejectamenta from volcanoes, and secondly that in the upper regions of tornadoes where *only* ice particles are present—so that there is no question of the freezing process itself being involved—the electrical effects reach an unexampled intensity.

We cannot yet deal with the physical details of this process of charge separation, but can say that, in all probability it will depend on the nature and number of the dust particles present in the gas, their relative velocities, and the gravitational force. Arguing on such lines, and observing that the process of field-building to breakdown in a thundercloud requires a period of the order of 100 seconds from the time at which radar reflections are first observed from condensations in the thundercloud, the writer estimated that in the much more tenuous atmospheres of the long-period variable stars a corresponding time of the order of 10^8 to 10^9 seconds would be required. The actual periods between the successive outbursts of light from these stars is 100 to 600 days, or 10^7 to 10^8 seconds—as good an agreement with the rough " theory " as can be expected.

Is there the necessary dust in their atmospheres to account for the electrical effects? Decidedly, yes. At light minimum the extra dust formed owing to the cooling of the gas between successive " thunderstorms," is sufficient to cut down the star's light by a factor of between 10 and 100. In the atmosphere of the galaxies the proportion of dust particles to gas molecules exceeds by many powers of ten the ratio of solid particles to gas molecules in thunderclouds. Observation, as we shall see, indicates that the time required for the field to build up to breakdown in galactic atmospheres is, as expected, much greater still and of the order of 10^9 to 10^{10} years.

The dust particles or grains in galactic atmospheres are known to exist (from observations on the degree of polarization of starlight); to be needle shaped; and to be oriented in one direction in any one part of space, as they would be by an electric field. So the requirements of the theory would appear to be fulfilled even in the extensive galactic atmospheres containing only about 1 atom per cu. cm, in contrast to the 10^{19} molecules per cu. cm which make up our own atmosphere.

Process of Electrical Breakdown

Evidence in support of the existence of electrical discharges in stellar and other atmospheres is plentiful. How else can one explain the origin of light of a kind which could only come from atoms subjected to temperatures of a million degrees, in atmospheres at less than 1,500°K to 4,000°K? The situation is exactly analogous to what happens in a thunderstorm, when light from a source at 50,000°K to 100,000°K is suddenly emitted from an atmosphere that is at about 280°K.

We have seen that the time interval between these outbursts in the atmospheres of the long-period variable stars is such as we should expect for the time necessary for the build-up of the electric field to breakdown. Similarly, the duration of the outbursts is of the order to be expected in view of the dimensions involved—those of our planetary system, i.e. 10^{14} to 10^{15} cm—and the velocity of propagation of electrical discharges. The latter should be independent of the gas density, since it depends on the product of the breakdown field, which is proportional to the density, and the mean free path of electrons in the gas, which is invesely proportional to the density. The velocity of propagation of the lightning leaderstroke is about 3×10^7 cm per second, so the duration of the discharges will be (10^{14} to 10^{15} cm) $\div 3 \times 10^7$ cm per sec, or about 10^7 sec, in good agreement with the times during which the bright emission lines appear in the stars' spectra.

This work was triggered off by Professor Chapman's Kelvin Lecture in 1941, and a summary was published in 1944. In 1946 Dr. J. S. Hey published the observations which initiated the study of the whole new field of radio-astronomy. This indicated at once that the universe is not running on gas, but on electricity. The existence of radio-astronomy might almost be regarded as a possible prediction of the discharge theory which the writer failed to make! We shall see later that it is the only theory which can account for the fundamental requirements of all theories of the origin of cosmic

Research Report

based on studies made by

Dr. C. E. R. Bruce,

research physicist at the British Electrical and Allied Industries Research Association (E. R. A.), Leatherhead, Surrey

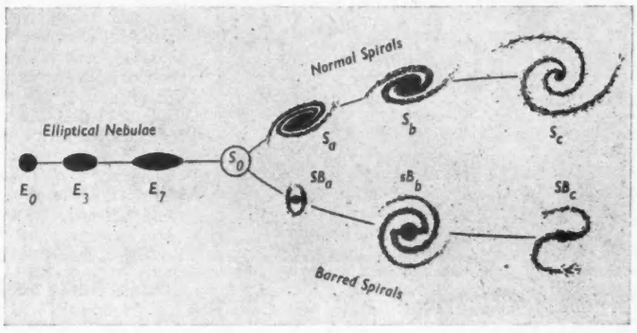


Fig. 1 Hubble's sequence of nebular or galactic types.

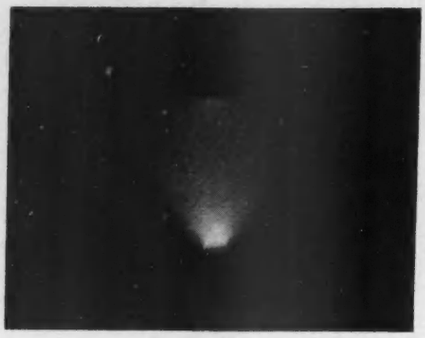


Fig. 2 Photograph of an arc discharge, taken by L. A. King, Electrical Research Association.

radio noise, which otherwise remain mere necessary postulates.

Aggregation of Matter

One of the crying needs of existing theories is a mechanism to explain the concentration of matter as observed, for example, in the spiral arms of the galaxies. Fig. 1 shows Hubble's scheme of galactic evolution. On the electric field and discharge theory, as described as long ago as 1944[1] the radial atmospheric electric field is gradually built up in the globular and elliptical nebulae or galaxies on the left of the diagram, until breakdown occurs at SO, "this critical point in the evolutional development of nebulae," as Hubble himself described it, where there seemed to him to be indications of some "cataclysmic action," is a role which electrical discharges on a galactic scale would amply fulfil.

During the early stages of the theory this role of electric discharges in collecting together the atmospheric matter was merely a postulate, though the writer ought to have known better, for in 1937 R. C. Mason had shown that, as a result of the tendency of the conducting particles in an electric arc to move in towards the axial regions, the gas pressure there is increased by an amount proportional to the product of the current and the current density. One can therefore predict that in all these cosmic discharges the gas pressure will be increased by this effect. It was only in May of this year that news of the observation of this increase of pressure in such a cosmic discharge was published. Two observers at the Sacramento Peak Observatory published the results of their observations on a solar prominence, and deduced that "the gas pressure must have been ten times higher at the centre of the (solar) flare than 20,000 km out." So that this major deduction from the electric discharge theory is confirmed.

Cosmic Gas Jets

However, the proof that such an effect existed did not need to await this last observation. Since the pressure increase depends on the product of the current and the current density, it follows that if either of these two factors varies then a pressure gradient, and hence a flow of gas, will be set up. In the electric arc, for example, the current is constant along the arc, but the current density increases at the electrodes. The pressure is therefore a maximum there, and decreases rapidly as the current density decreases as the arc diameter increases (occurring in the manner illustrated in Fig. 2). This variation in current density results in the anode and cathode jets. It is the jet of gas so generated at the welding rod which carries over the metal globules on to the weld, as Mr. L. A. King has recently shown in these Laboratories. Fig. 3, showing a frame from a high speed colour film (10,000 frames per second) of a welding arc, taken by Mr. J. C. Needham, also in the ERA Laboratories, demonstrates the entrainment of the metal globule by the gas jet, and the luminous tail of metal vapour blown *ahead* of the drop.

The velocity of the gas will ultimately be that of sound in the hot gas, which last can be used in many cases as a cosmic gas-velocity thermometer. Applying the idea first to the lightning discharge, the period of high current flow is 100 μsec to 1 msec, during which the arc temperature will reach 50,000° K to 100,000° K. The velocity of sound in ionized and dissociated air at these temperatures is 5 to 10 km per sec, so that, in the times mentioned, material vaporized at the earth's surface will be blown up the lightning channel to heights of between $\frac{1}{2}$ and 10 m. The theory therefore explains why metal lines have been observed in the spectrum of the lightning discharge up to a height of 2 m above the ground.

In the discharges in the extensive atmospheres of the long-period variable stars discussed earlier, both the current and the current density will decrease upwards in the discharges, which will therefore form long magnetic hose pipes, so to speak, along which the gas will be squirted by the pressure gradient. The spectra of the discharges show that ionized metals and ionized helium are present, indicating gas temperatures of between 5,000° K and 10,000° K, the gas being mainly hydrogen (about 80 per cent) and helium (about 20 per cent). The velocity of sound in such a gas at these temperatures will be between 8 and 12 km per sec, so that the emission lines in the spectrum of the hot gas should be displaced towards the violet by amounts corresponding to the Doppler shifts at these velocities, only the discharges on the near side of the stars being visible. Two observers have investigated these shifts at Mount Wilson Observatory, and for two groups of these stars have found mean velocities of 9 and 11 km per sec, in excellent agreement with the theoretical values, especially when one recollects that these velocities might *a priori*, and in the absence of the discharge theory, have had any values.

The theory enables us to set an upper limit to the gas velocities which can be reached in these discharges, in which the temperature will only go on increasing until values are reached at which thermonuclear fusion processes are engendered in the gas. When these are initiated then the increase in pressure caused thereby will balance the inward pressure of the magnetic pinch effect, and prevent further increase of temperature. It is to be expected that these nuclear fusion processes will be initiated at temperatures between 10^{8}° and 10^{9}° K, at which tempratures the velocity of sound in ionized atomic hydrogen reaches values of 1,750 km per sec, and 5,400 km per sec respectively. The theory therefore predicts that in the largest cosmic discharges, for example those occurring in the atmospheres of the extragalactic nebulae, the highest gas velocities produced will be somewhere in that range. Seyfert, also at Mount Wilson Observatory, has investigated this question in galaxies showing bright line spectra, which last indicate the occurrence of electrical discharges in their atmospheres, and has derived therefrom gas velocities lying between 1,850 and 4,500 km per sec, in good agreement with the theoretical upper limit predicted by the discharge theory.

Cosmic Radio Sources

Fig. 4 shows the well known globular galaxy NGC 4486 which is the radio source Virgo A. This is the type of galaxy in which it was suggested in the original account of this work that the dicharges would occur, which form the spiral arms. Careful filtering of its light enabled the photographic enlargement of its central regions in Fig. 5 to be obtained. This shows the thermonuclear discharge which is about 6,000 million million miles long, and which will go on increasing at the rate of about 2,500 miles per sec for a period of the order of ten to a hundred million years.

Fig. 3 High-speed photograph of a welding arc, taken by J. C. Needham at the Electrical Research Association's Laboratory.

The energy radiated is "colossal," and the suggestions put forward to account for it by astrophysicists include "the galaxy's capture of a gob of anti-matter coming from an anti-galaxy," and alternatively, exploding stars which detonate explosions in other stars in a "gigantic and glorious galactic firework display."

The thermonuclear discharge supplies not only the energy required, but also the magnetic field and the relativistic electrons, for if the velocities of the atoms reach 4,000 km per second, even the *average* velocity of the electrons reaches a large fraction of the velocity of light.

As regards the energy, this can be calculated from the change which the discharge effects in the atomic constitution of the gas. Galaxies in which breakdown has occurred are found to contain two populations of stars. Population I stars are found in the spiral arms; they are the relatively new stars which have been formed relatively quickly in the high density gas and dust gathered together by the discharge. They are therefore formed of gas which has been subject to "thermonuclear" temperatures for 100 million years, so that the proportion of heavy atoms in it will have been increased as compared with that of the original or primordial gas which earlier went to the formation of the older Population II stars. These observed proportions are: for Population II stars, 0·003; for Population I stars, 0·03. From this observed change, which only the discharge theory explains, we can calculate the atomic energy liberated during the life of a radio-galaxy to be 10^{60} ergs, which is precisely the value deduced from a consideration of the observed rate of energy radiation from Virgo A.

Concluded Opposite

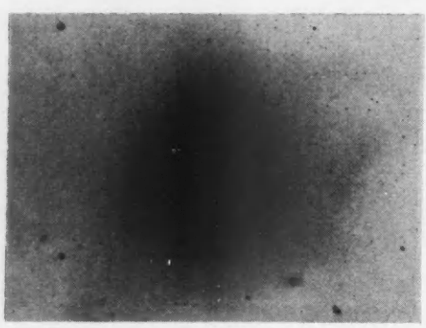


Fig. 4 Radio source of Virgo A; globular nebula NGC4486.

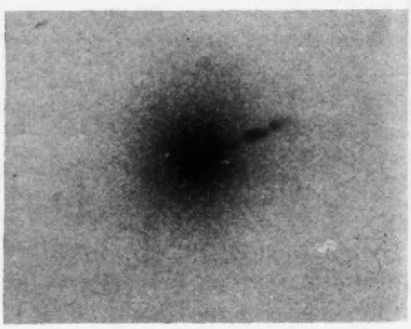


Fig. 5 Enlargement of central regions of NGC4486.

Continuing "Arc Welding" Theory

In a recent lecture to the British Association, Professor Bondi suggested that theories should "live dangerously" by making predictions which could then be proved or disproved by observation or experiment. Few theories can have lived more dangerously in recent years than the electric field and discharge theory. For example, early in 1959 the prediction or deduction was made in a contribution to the I.E.E. Convention on Thermonuclear Processes, which was later published in *Nature*, that during the discharges associated with solar flares the temperature must reach over a hundred million degrees somewhere between the sun and the earth's orbit. Within months this prediction was proved true by satellite observations made by US Navy scientists.

Perhaps the most striking of these predictions was the deduction from the theory's interpretation of observations on the light from some stars that *spiral nebulae* must exist on a *stellar* as well as a *galactic* scale. In the spectra of these stars there are pairs of bright emission lines, where in normal spectra there are single lines. One of these two components is displaced to the violet of the line's normal position in the spectrum, the other to the red.

To understand these we consider first Hubble's Variable Nebula associated with the star R Monocerotis. On the discharge theory this is a star in which the gas and dust of the star's atmosphere has been collected along the channel of a huge electrical discharge, probably during a nova outburst. In the region of high density thus produced, thunderstorm conditions are practically continuous and lead to the variability of the light from the nebula, first discovered by Hubble.

Just as happens in the discharges in the atmospheres of the long-period variables, the hot gas is blown outwards in the atmosphere along the "magnetic hose-pipe or nozzle" formed by the discharge channel. If one of these cometary nebulae is directed towards us in the line of sight, then the star's spectrum would contain bright emission lines displaced towards the violet, as many stellar spectra do. If now, stars exist with two of such cometary nebulae in the same line, and this line is the line of sight, then the stars' spectra would contain just such pairs of emission lines as we have described. As Hubble's Variable Nebula is easily photographable it followed that there might be examples of double stellar nebulae, and enquiries were made of a number of astronomers if they knew of any such photographs. Curiously enough even some who have worked and are working on the so-called planetary nebulae confessed that they did not know of any such photographs. However, the late Dr. Merrill of Mount Wilson Observatory wrote that, if anywhere, they were most likely to be found in a paper by H. D. Curtis published in Lick Observatory Publications in 1918. A selection of photographs taken from that source amply fulfilled the theoretical prediction, and showed that, just as happens when the corresponding phenomena take place on a galactic scale, the result is often a spiral or a barred-spiral nebula.

Epilogue

It is indeed strange that all the above theoretical success has been achieved on the basis of the introduction of one new major variable—the electric field—into our considerations of the universe, after 300 years of gravitation plus a series of *ad hoc* postulates, which become more bizarre as the phenomena to be explained increase in apparent complexity. Stranger still that against the existing theoretical background of self-confessed inadequacy, the clarifying electric fields should still frequently be described as "quite impossible".

Reference

[1] C. E. R. Bruce, "A New Approach in Astrophysics and Cosmogony", London, 1944 (private publication.)

Rough Running of Gas Turbines

Many defects of gas turbines, such as wear on bearings and failure of blades resulting in dynamic unbalance, can be detected and diagnosed at an early stage by careful vibration measurement.

This work can now be simplified by a new instrument which has been developed by Dawe Instruments Limited to the specifications of Rolls-Royce Limited. Known as Type 1416 Roughness Measuring Set, it is essentially a vibration meter, but specially adapted for indicating abnormal vibration in gas turbines in the presence of normal masking vibration. It has built-in high and low by-pass filters and an adjustable "bump" filter. Indication is thus restricted to the range in question.

This new instrument enables the running characteristics of a gas turbine to be evaluated quickly and simply.

The unit has a multi-position switch by means of which the bump filter can be preset to engine speeds from 11,000 to 17,000 rpm in steps of 1,000 rpm. A second knob controls the degree of attenuation given by the filter. When correctly set, the meter gives a direct reading of residual vibration in terms of displacement from 0 to 0·1 in peak-to-peak, or in terms of velocity from 0 to 100 in per sec peak.

This new instrument enables smoothness in operation to be evaluated quantitatively in a quick and simple manner. Periodic readings on the same engine give immediate indication of deterioration, while readings taken in the course of production-line testing provide a reliable standard for comparison. The fact that the instrument is fully transistorized and portable greatly facilitates its use in service hangars and on test beds.

Dawe Instruments Limited, Western Avenue, Acton, London W3.

Army to Adopt Vigilant Missile

The British Aircraft Corporation has announced that the British Army is to adopt the Vickers Vigilant one-man anti-tank guided missile. The weapon is to be used both by the infantry and by reconnaissance units of the Royal Armoured Corps. The Army's decision has been made after careful evaluation of all other competing weapons.

Lord Caldecote, Deputy Managing Director and Executive Director (guided weapons) of the BAC commented: "This is the first time that a guided missile developed entirely with private capital and at no cost to the taxpayer, has been bought by the British Forces. This success is ample justification of our faith in the weapon.

"The army will be getting full value for money, because of its great accuracy and the ease with which soldiers can be trained to use it. The cost of training and equipping an operational unit is considerably less with Vigilant than with any of its competitors. In addition, it is twice as effective on the battlefield."

Vigilant has a warhead which represents well over a third of the total missile weight and is capable of penetrating the armour of any known tank. In a recent NATO demonstration of Vigilant, two infantrymen put four tanks out of action in 47 sec.

New Bottom Pouring Furnace

A bottom pouring furnace, which interrupts the flow of molten metal as required, and which has an easily restored outlet and an unobstructed charge container, has recently been invented at the Aldermaston laboratories of the UKAEA.

A cylindrical charge container sits inside a close fitting cup so that relative rotation is possible whereby an outlet in the charge container can be brought in line with outlets in the closing cup. Further rotation in any direction separates the outlets and stops the flow. By having the walls of this cup higher than the walls of the charge container it is ensured that any leakage charge falls into the receiver. By supporting the charge cylinder in the cup the weight of the charge improves the seal.

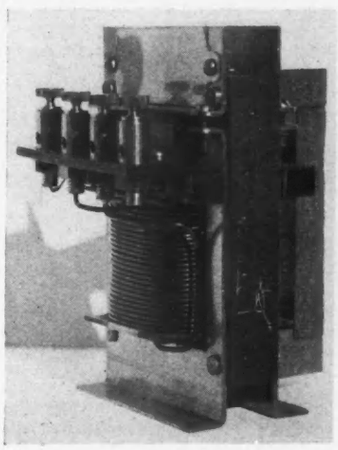
With this furnace, the condition of the inside walls of the outlets is of no significant importance so that it is only necessary to rub the surfaces of the charge container and closure cup to improve the surface finish.

Further information may be obtained from the Patents Licensing Officer, UK Atomic Energy Authority, 11 Charles II Street, London SW1.

Practical Use of Magnetoresistance

One of the first practical devices to use the phenomenon of magnetoresistance is a voltage regulator for tunnel diodes. Its output voltage is kept constant by an indium antimonide semiconductor, measuring 0·75 by 0·25 by 0·004 in, whose resistance varies in proportion to the strength of an applied magnetic field.

An increase in input produces a stronger field in the electro-magnet (coil of wire shown in illustration), thereby increasing the resistance of the indium antimonide element. A decrease in input weakens the magnetic field, thereby decreasing the resistance of the element.



A voltage regulator for a tunnel diode represents one of the first practical applications of the magnetoresistance effect.

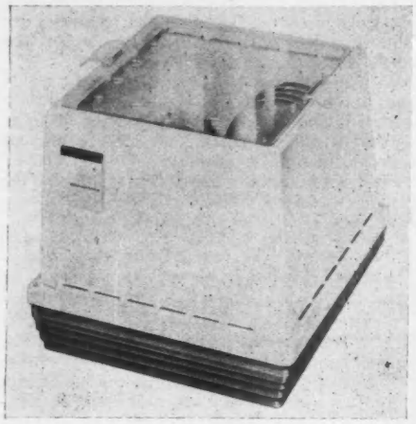
The regulator can maintain a 0·15 volt output within ± 5 per cent at 0·1 A—even when the load resistance changes 50 per cent with a simultaneous 10 per cent change in input voltage, which is normally 1·5 volts. Much more precise regulation than this can be achieved when magnetoresistance is used in regulators with outputs of one volt or more.

This magnetoresistance voltage regulator was developed at the Battelle Memorial Institute, Columbus, Ohio, in a research programme sponsored by the USAF Systems Command.

For the Kitchen

DISHWASHERS have still a long way to go in this country before the potential market is saturated. Many people doubt their saving in real time or labour, and the initial cost is still rather high. Direct selling methods now being introduced by the Colston-Rolls organization are expected to bring the cost of this make down considerably, but to most households the outlay still has to be looked at twice.

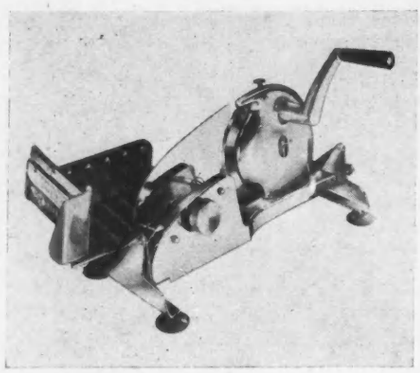
From America comes a simple form of dishwasher that relies on the power of the water supply to produce the spray and the washing action. The unit is the Hydromatic and is made by Spaulding Industries Inc., 3520 N. Spaulding Avenue, Chicago 18, Illinois, USA. The general



(*Above*) *Only water is required for the small Hydromatic dishwasher.*

(*Right*) *The Prestcold dishwasher is fully automatic and will take utensils as well as plates.*

(*Below*) *When not in use the General slicer folds flat in to fit a drawer.*



appearance can be judged from the illustration. It is intended to stand on the draining board and discharges into the sink.

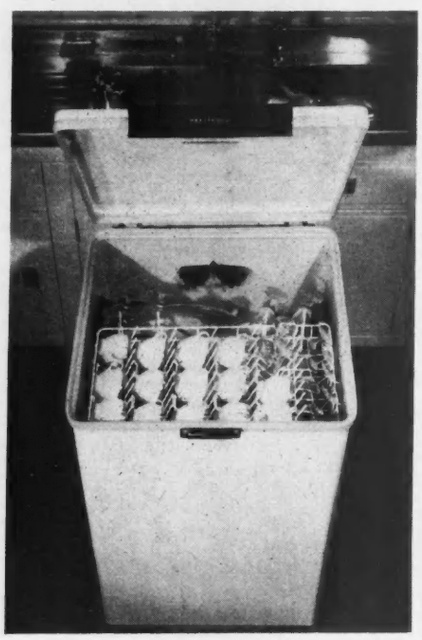
The connection to the water supply is made by a flexible hose—no other connections are required except the outlet which fits into a groove below the hose connection. One advantage is that the unit is compact; measuring only 21½ in over the inlet connection, by 19 in by 15 in deep, it takes very little room and can stand under a wall cabinet.

On the inlet connection is a container for detergent, holding enough for a complete wash. The detergent is introduced automatically as the water flows in. The complete washing and rinsing cycle takes from 6 to 10 minutes where the water supply is at a reasonably high pressure; for districts of lower pressure an additional two or three minutes should be allowed. The makers warn that the washer will not remove dirt or stains that would require the use of an abrasive in usual hand washing. A normal full load for the machine is 24 plates and dishes of various sizes, and up to 16 pieces of silver ware making some forty pieces in all.

As the washer weighs only 19 lb it is easy to move about.

Also from America is the slicing machine shown in the second illustration. This is a product of the General Slicing Machine Company Incorporated of Walden, New York, USA. Its particular attraction is for the small kitchen as it is made to fold away into a drawer. Folded, it measures 14½ in long by 8½ in wide by 4⅜ in high, and set up 14½ in long by 12 in wide by 8½ in high.

The standard model is made to slice any item of food such as meat or fruit up to 8¼ in wide by 5 in high, into slices of any thickness from wafer thin to ¾ in. It is made of zinc die castings and steel, finished with chromium plating. To protect the hands it is fitted with the Safe-T-Guard which stops operation while the hand is in a dangerous position. The blade, which is 6¼ in diameter, can be removed by two push



buttons for easy cleaning. Packed, the machine weighs 10 lb. The folding version is hand operated; motor operated machines are also available.

The third illustration shows a diswasher from Britain. It is one of the new range of domestic equipment being introduced by Prestcold who hitherto have concentrated on refrigerators. A fully automatic machine, it is mobile and draws its supply from the ordinary tap. A heater in the water circuit keeps the wash temperature to 160° F, which is hotter than hands can bear. A choice of two cycles is offered; the normal for lightly soiled dishes and dusty glassware and the Super for really heavily soiled utensils.

A full load for the machine is 100 pieces of cutlery, and 10 each of dinner plates, side plates, soup/dessert bowls, cups, saucers and glasses. Alternatively, the racks can be removed and a wide variety of utensils can be washed including saucepans and roasting pans. A full wash takes nine gallons of water, which is circulated by a pump and through a filter to remove debris. In spite of the large capacity, the floor area required is only 24 in by 26½ in; the height is 36 in. Quick loading and fully automatic operation are features of the machine, the cycle including drying the contents after the wash.

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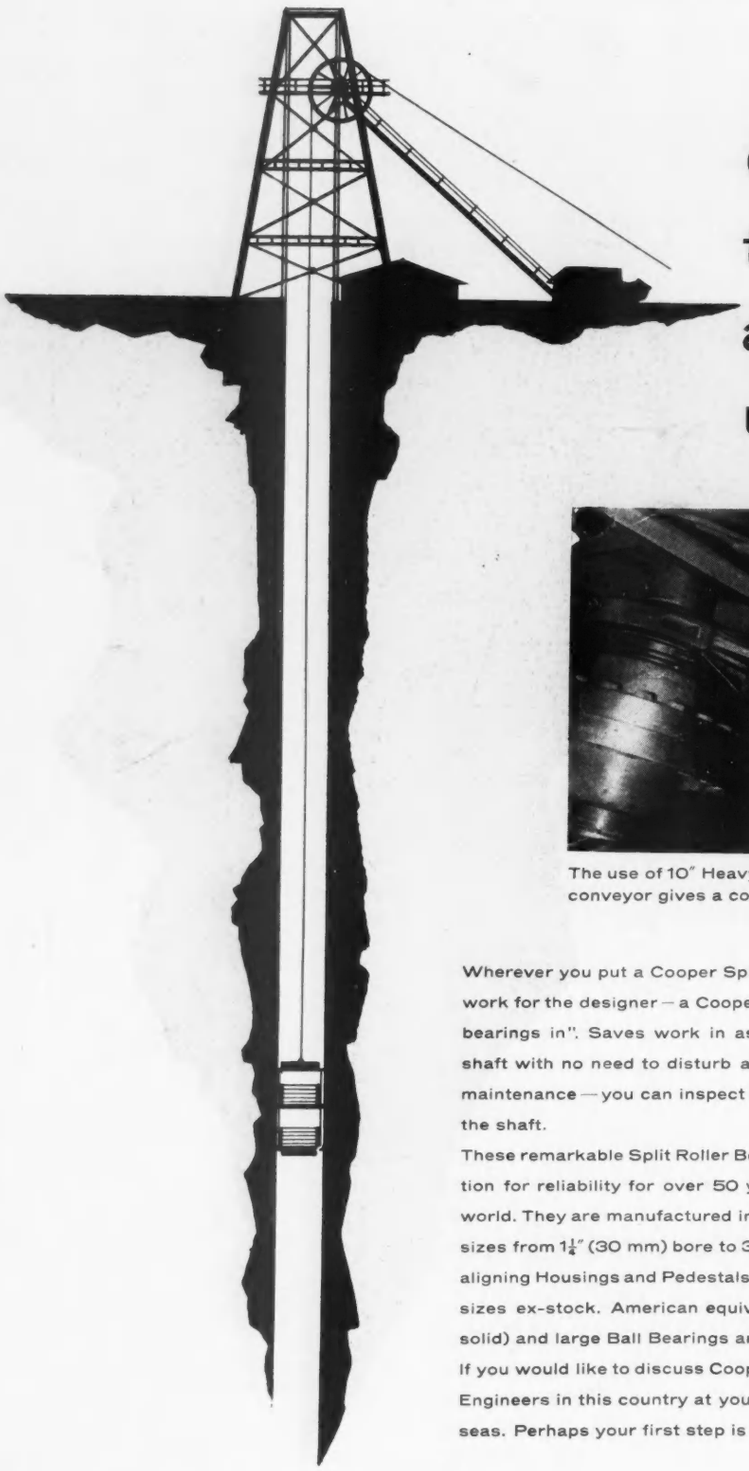
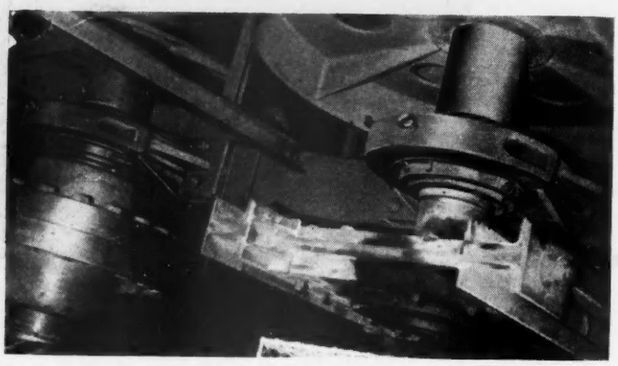


Coopers on the surface... and Coopers underground...



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Wherever you put a Cooper Split Roller Bearing to work, it *saves* work. Saves work for the designer—a Cooper cuts out all the worry about "how to get the bearings in". Saves work in assembly—a Cooper is simply *positioned* on its shaft with no need to disturb adjacent gears, couplings etc. Saves work in maintenance—you can inspect the actual rolling surfaces without disturbing the shaft.

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If you would like to discuss Cooper Roller Bearings there is a team of District Engineers in this country at your service—and agents in 54 countries overseas. Perhaps your first step is to send for our illustrated catalogue.

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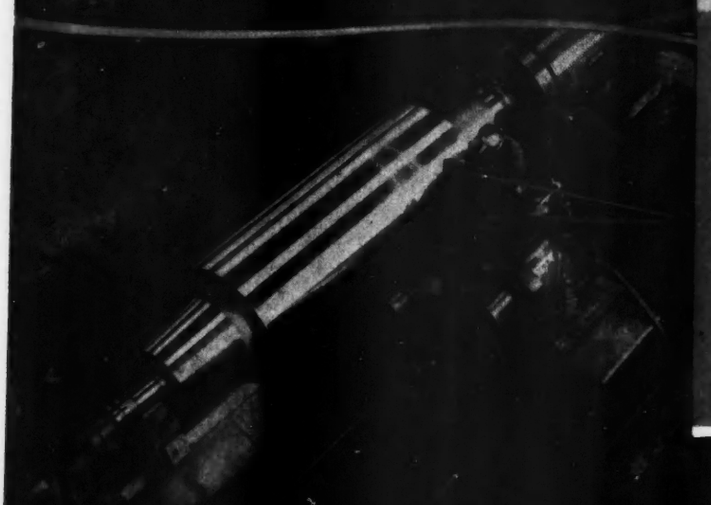

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Applications are invited from firms wishing to be considered for inclusion in a panel of contractors to be invited to tender for the engineering work involved in the installation of the new central boiler plant at the above hospital.

The installation will comprise 4 Economic oil fired boilers, together with all associated services, steam main distribution and calorifier heating and domestic hot water services for the existing hospital, all in accordance with specifications and drawings prepared by Mr. R. B. Giles, Consulting Engineer of 26, Seymour Street, London, W.1. The electrical services associated with this work will form a sub-contract of the Mechanical Engineering Contract. The associated building work will be the subject of a separate contract.

Applicants are required to have had experience of large scale contracts and to be capable of undertaking work in the region of £100,000. Names and addresses of two professional engineers under whose supervision they have worked should be quoted.

Letters of application should be submitted to the SECRETARY, NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD, 40, EASTBOURNE TERRACE, LONDON, W.2, not later than MONDAY, 15th JANUARY, 1962. H 806

SALES BY AUCTION

E R BY ORDER OF THE SECRETARY OF STATE FOR WAR

SALES BY GOVERNMENT SURPLUS STORES AUCTION

NEXT SALE JANUARY 9

Central Ordnance Depot, Didcot, Berkshire.

Auctioneer: Simmons & Sons (Dept. J), 12 Station Road, Reading, Berkshire. (Tel. 54025)

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Lathes by Kitson, Mann, Sentinel, etc.	Tangye Hydraulic Press, 100 tons cap.

SALES IN JANUARY AND FEBRUARY, 1962

Jan. 18 Jan. 19	Machine Tools, Miscellaneous Stores at W.D.S.D., Rotherwas, Hereford. Auctioneer: Russell, Baldwin & Bright (Dept. J), 20/21 King Street, Hereford. (Tel. Hereford 4366).
Jan. 31	Machine Tools, Miscellaneous Stores at N.C.O.S.D., Barlow, near Selby, Yorks. Auctioneer: Bartle & Son (Dept. J), 50-52 Merrion Street, Leeds, 2. (Tel. Leeds 20898).
Feb. 5-9	Vehicles, Earth Moving, Roadmaking, Lifting Equipment and Motor Cycles at W.D.S.D., Ruddington, Notts. Auctioneer: Walker, Walton & Hanson (Dept. J), Byard Lane, Bridlesmith Gate, Nottingham. (Tel. 54272).

APPLICATION FOR CATALOGUES, available 14 days prior to date of sale, should be made to the auctioneers shown above (price of catalogue 1s. 0d., p.o. only).

G 917

ADVERTISEMENT FOR TENDERS

BRITISH COLUMBIA ELECTRIC COMPANY LIMITED

PEACE RIVER HYDRO-ELECTRIC PROJECT

Tenders are invited for a contract for construction in the Province of British Columbia, Canada, of:—

CONTRACT No. 3

PORTAGE MOUNTAIN POWER PROJECT

DIVERSION TUNNELS

Principal Items of Work:—

(*a*) Excavating and concrete lining three 48-ft. internal diameter horseshoe-shaped diversion tunnels each approximately 2,500 ft. long.

(*b*) Excavating approximately 1,200,000 cubic yards of rock for intake open approach channel.

(*c*) Constructing tunnel intake and outlet works.

(*d*) Grouting of bedrock for part of main embankment grout curtain through which diversion tunnels pass, requiring approximately 55,000 linear feet grout holes, approximately 50,000 cubic feet of cement, and tests and exploratory work.

LOCATION

Portage Mountain Power Project is on the Peace River, British Columbia, at approximately longitude 122° 10′ W. and latitude 56° N.

CONSTRUCTION SCHEDULE

Contract No. 3 work is to commence April, 1962, and be completed August, 1963.

An access bridge across the Peace River near the Site, a 10-ft. by 10-ft. pilot tunnel, and clearing of part of the Site will be completed by others before April, 1962.

CONTRACT DOCUMENTS

Contract documents may be inspected at office of General Purchasing Agent, British Columbia Electric Company Limited, 970 Burrard Street, Vancouver 1, British Columbia, Canada, from Wednesday, January 3, 1962. Copies may be obtained for $50·00 plus $2·50 BCSS tax for first copy and $25·00 plus $1·25 BCSS tax for each additional copy, no part of which shall be refunded.

INSPECTION OF THE SITE

Tenderers must inspect the Site and should make arrangements through the office of the General Purchasing Agent.

CONDITIONS OF TENDERING

Tenders must be for the entire work included in Contract No. 3. B.C. Electric will name a number of grouting specialists who will be acceptable, either on a sub-contract basis or under other arrangements, to undertake bedrock grouting of part of main embankment grout curtain through which diversion tunnels pass.

B.C. Electric Co. Ltd. reserves the right to reject any or all tenders, and to accept any tender considered advantageous to it. B.C. Electric Co. Ltd. will not be responsible for any costs incurred by any Tenderer in preparing his tender.

TENDER DEPOSIT AND PERFORMANCE BOND

A tender deposit in the form of a certified cheque or a tender bond in the amount of $1,000,000 (Canadian) must accompany each tender. Tenderers must further submit with their tenders proof of their ability to furnish the required performance bond.

SPECIAL QUALIFICATIONS REQUIRED OF TENDERERS

Tenders will be considered only from Tenderers whose financial resources, technical ability, and experience are commensurate with the work to be performed, and who have successfully completed comparable work on other projects.

SUBMISSION OF TENDERS

Sealed tenders will be received until 2 p.m., Pacific Standard Time, on Thursday, March 8, 1962, at office of General Purchasing Agent at the aforementioned address, when the tenders will be publicly opened and read aloud. H 816

For 'Engineering' Appointments Section, turn to the centre of Editorial Section

TRADE AND TECHNICAL

THE DIRECTOR GENERAL OF INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, invites tenders for the supply of:—

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Forms of tender may be obtained from the above address on or after Friday, the 22nd December, 1961, at a fee of 10s. which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on Monday, 15th January, 1962.

Only the manufacturers (including their constituents or Associates authorised to commit them) or their accredited Agents who are in a position to supply the requirements from their own or their Principal's manufactures are invited to quote.

Please quote Reference No. 65/61/RLY.

H 830

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ROBERTSON MOTORISED GANG SLITTING MACHINE. Capacity ¼ in. Width of cutters 18 in. Dia. of cutter shafts 4 in. The machine is complete with a number of cutters 8¼ in. diameter, 2-speed gearbox. Motor drive 400/3/50.

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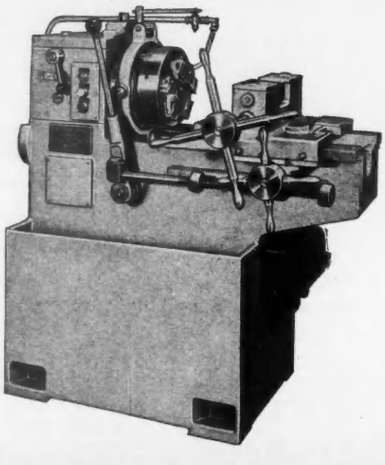

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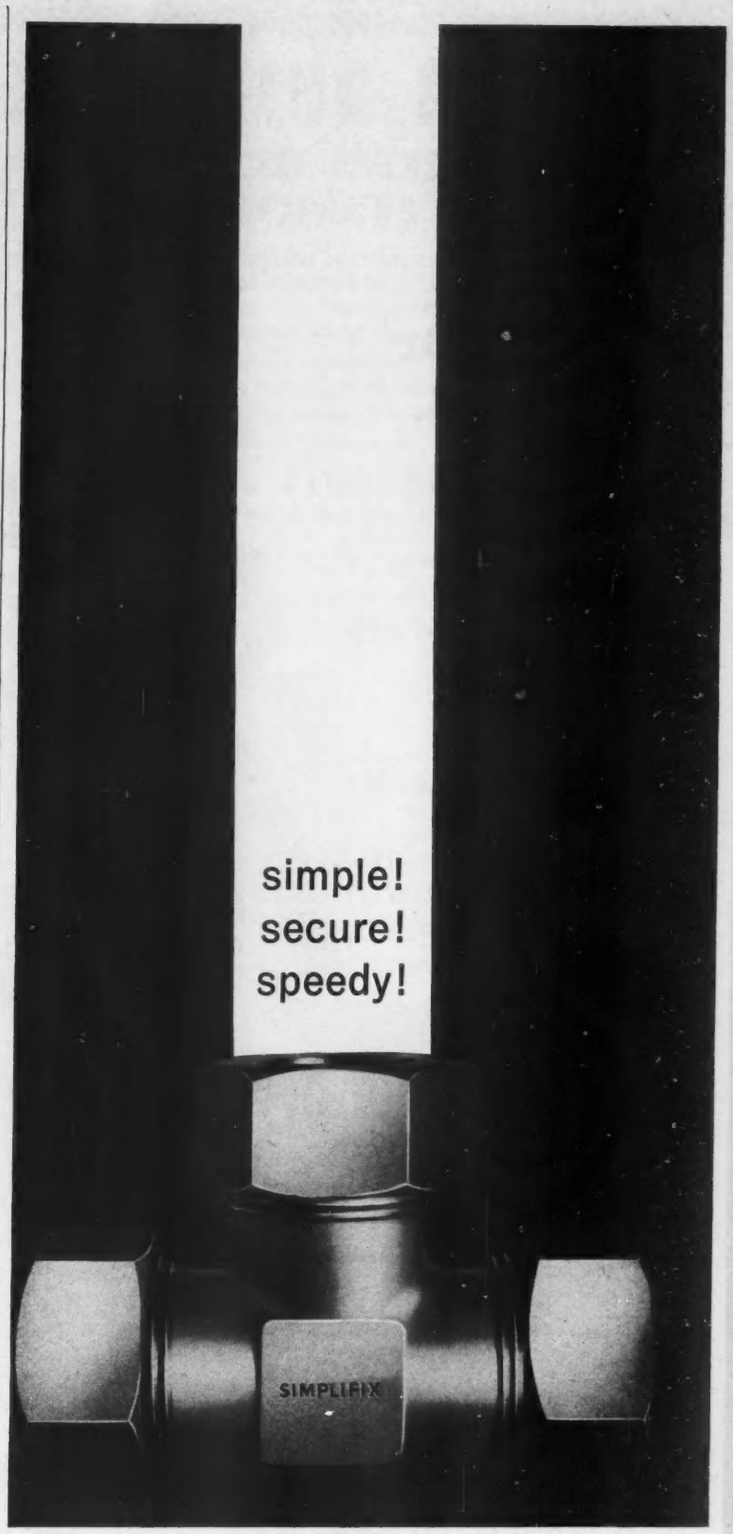

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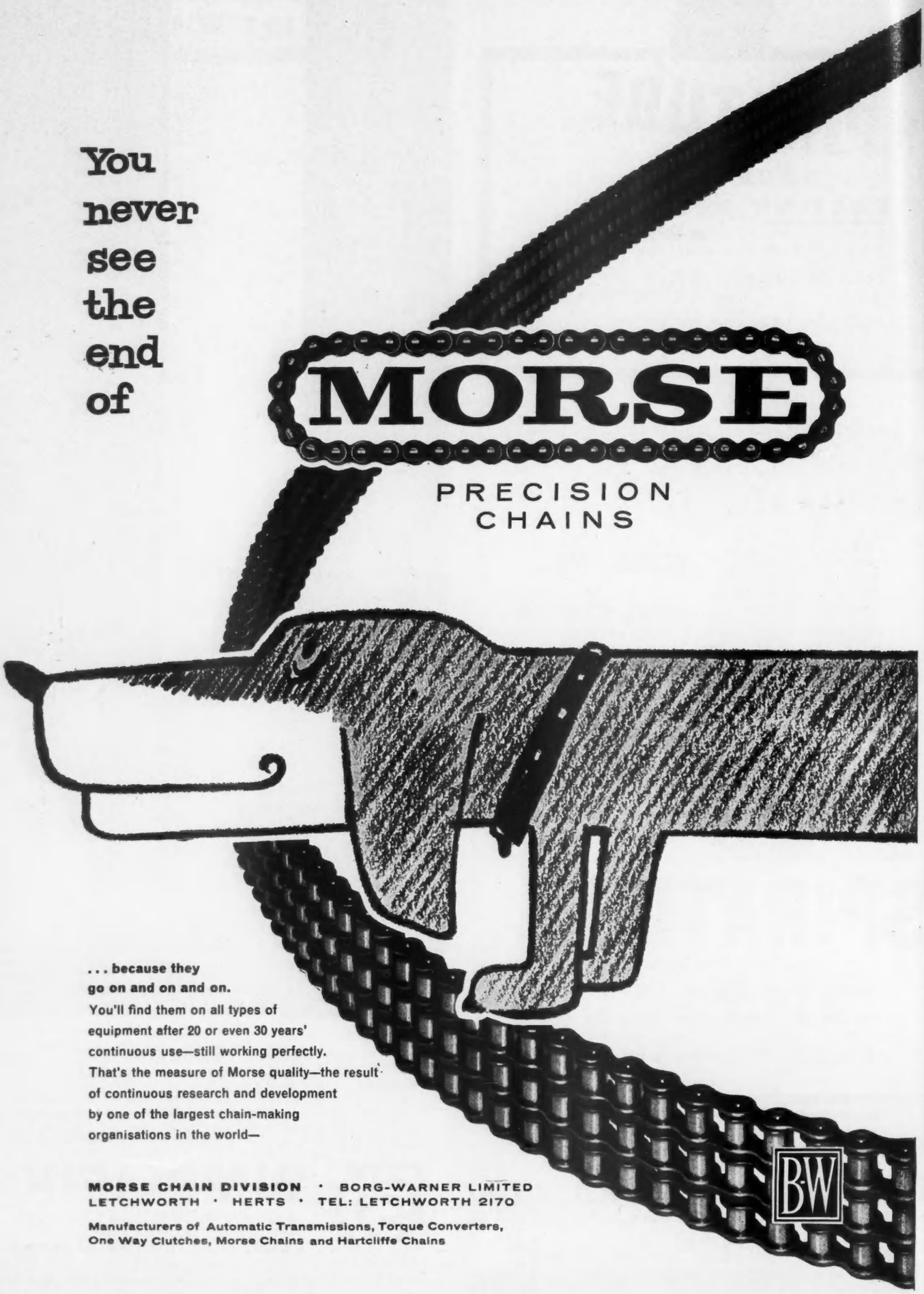

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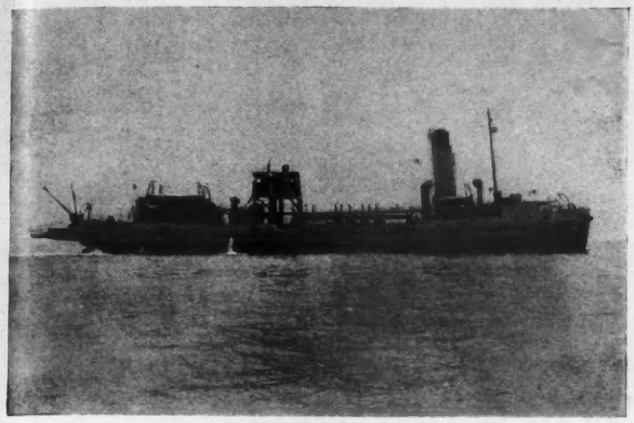

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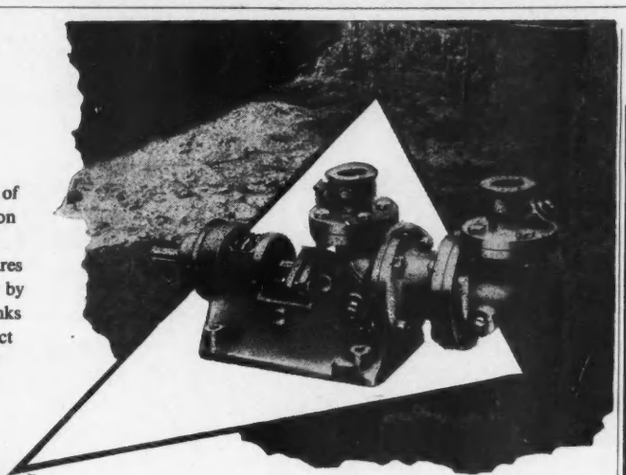

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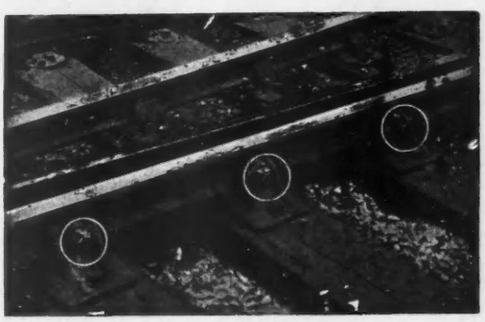

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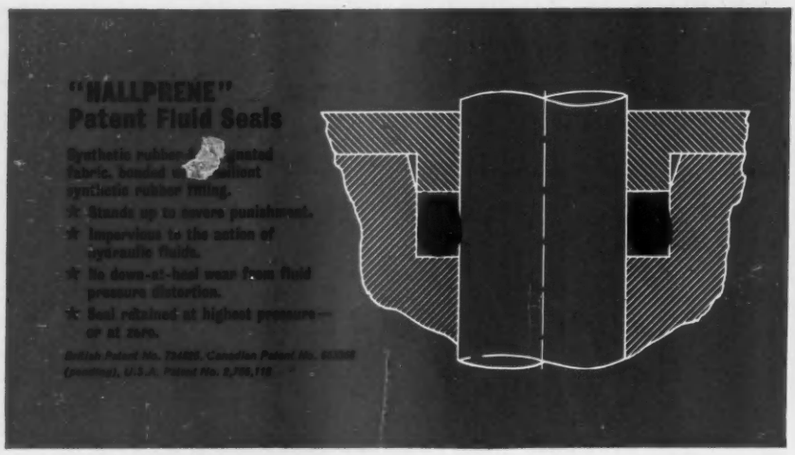
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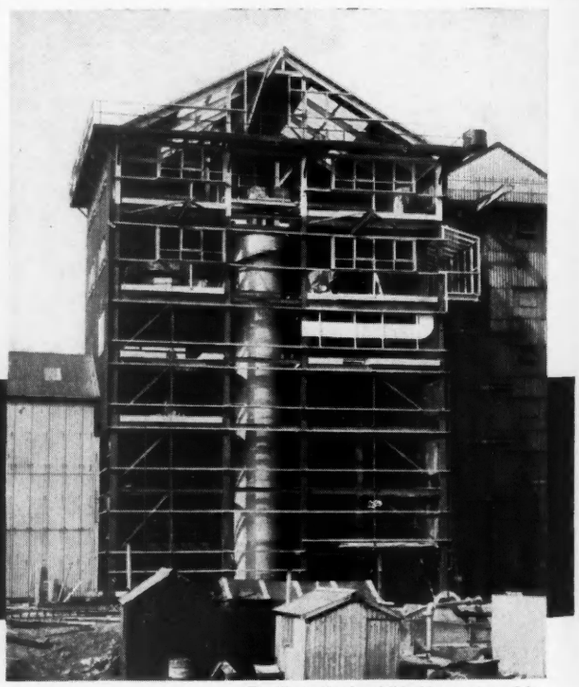

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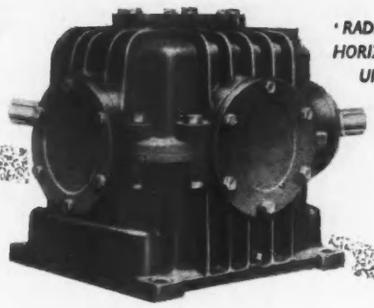
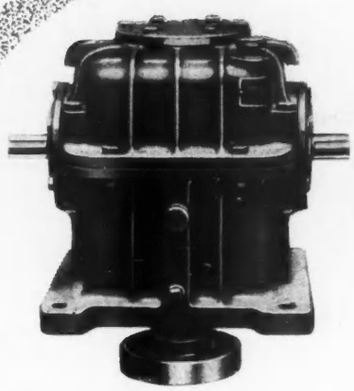


'RADIATION' HORIZONTAL UNIT



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If you are watching costs you will do well to install Crofts "RADIATION" Spiral Bevel Gear Units. They are precision generated to give accurate and continuous tooth engagement; they lower noise levels, reduce maintenance and production costs, and ensure the optimum use of expensive power.

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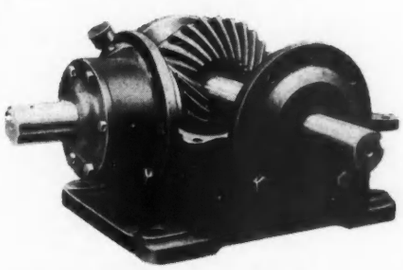

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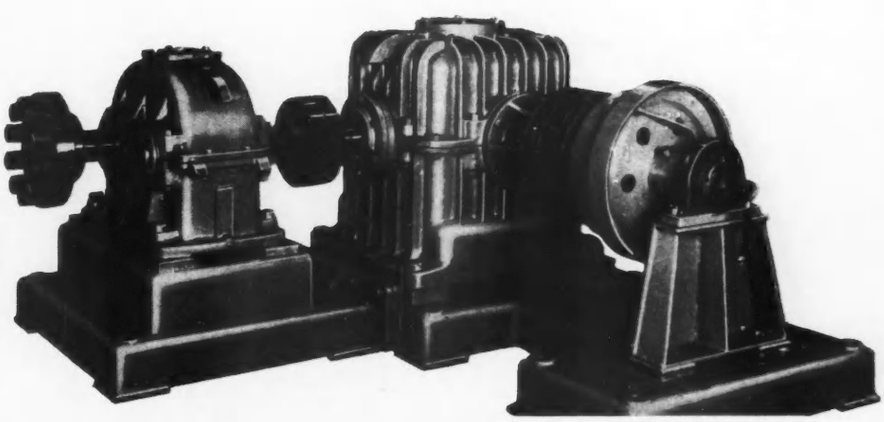

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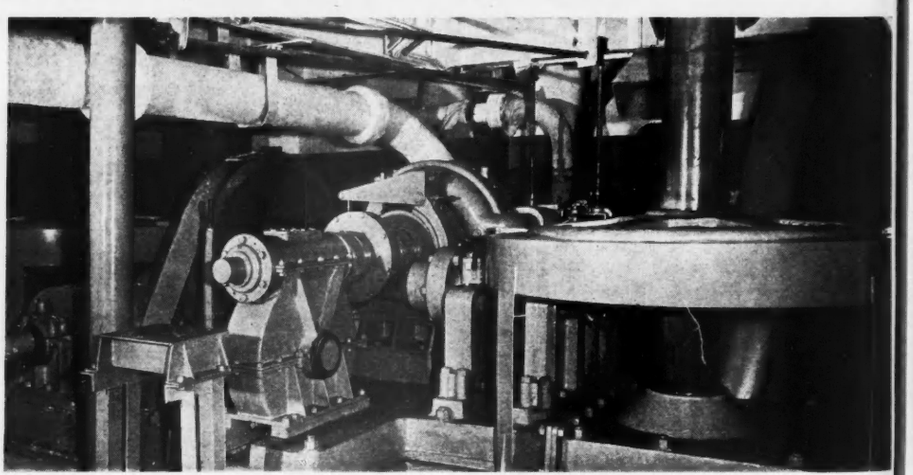

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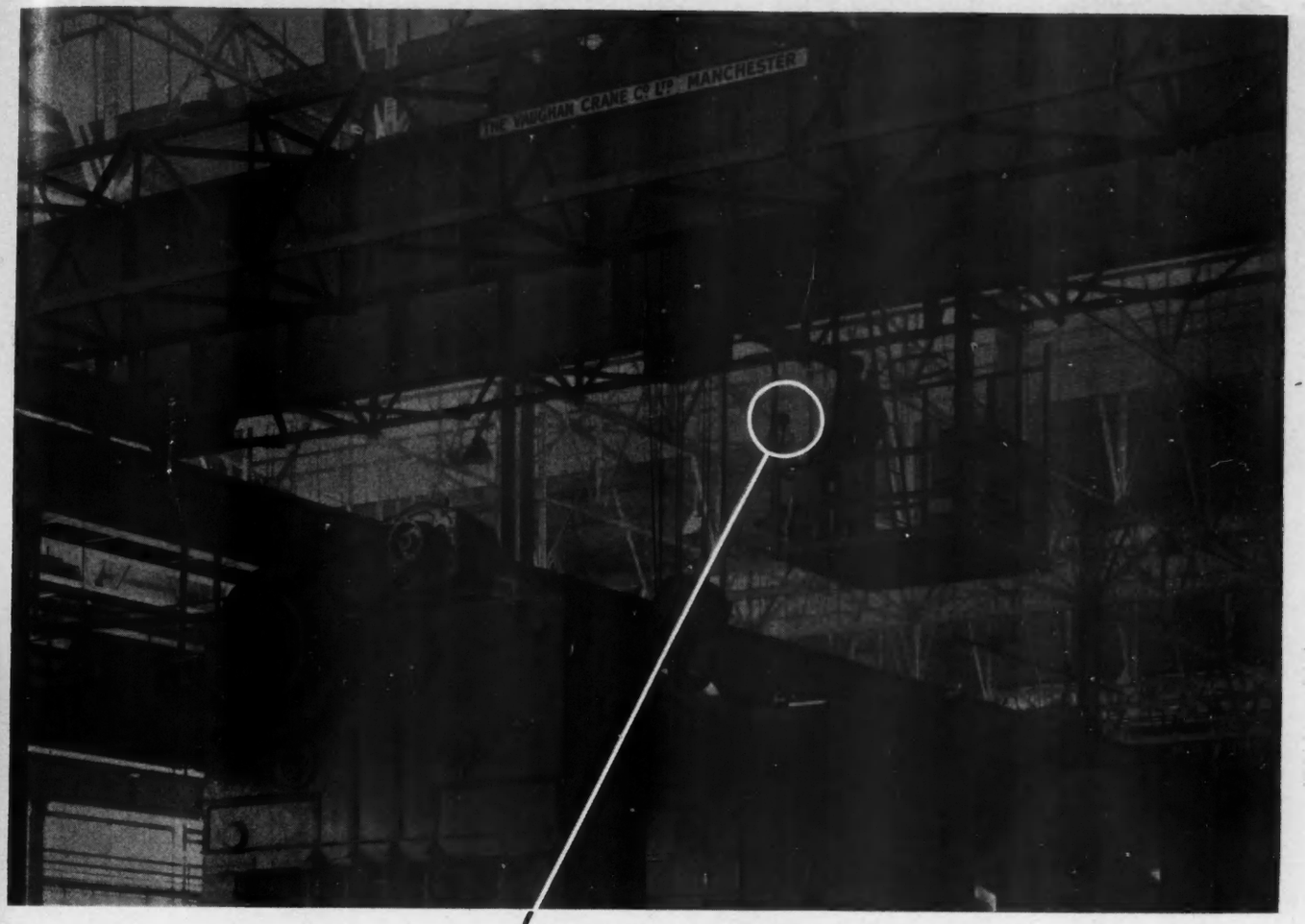

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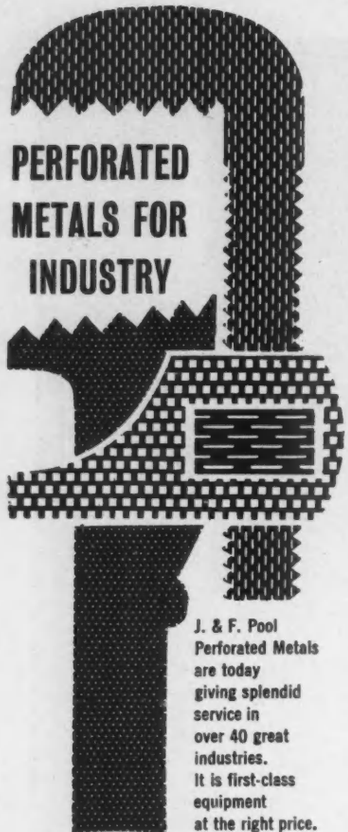

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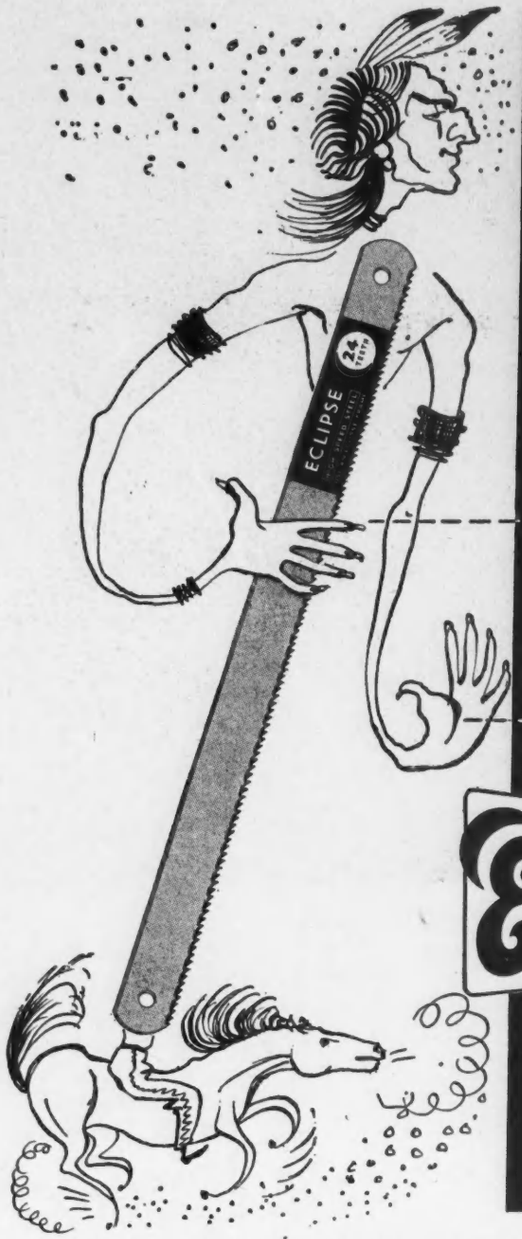

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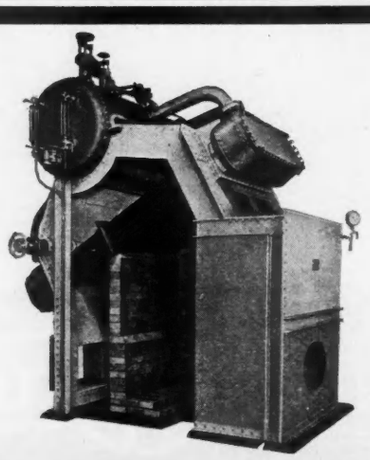

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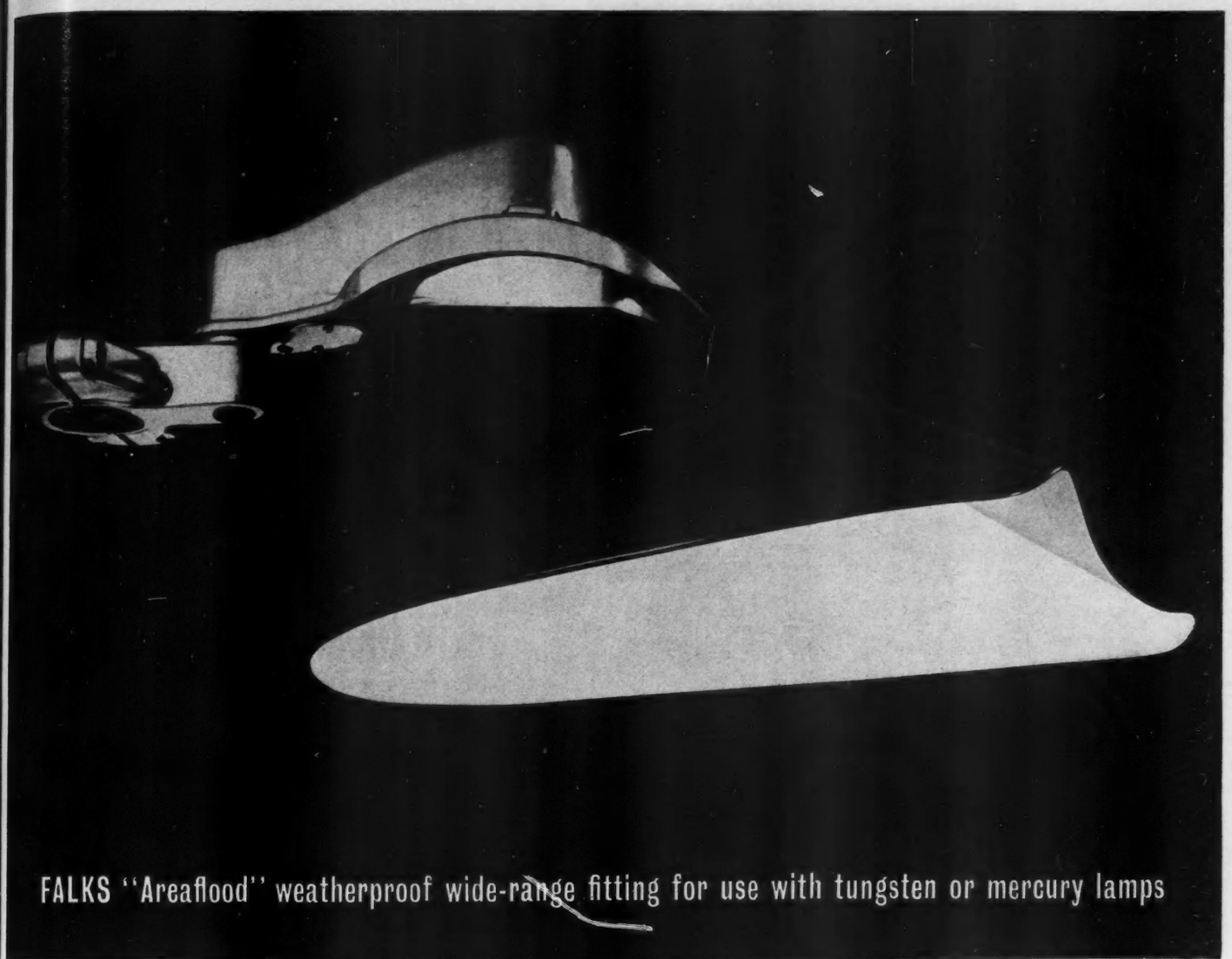
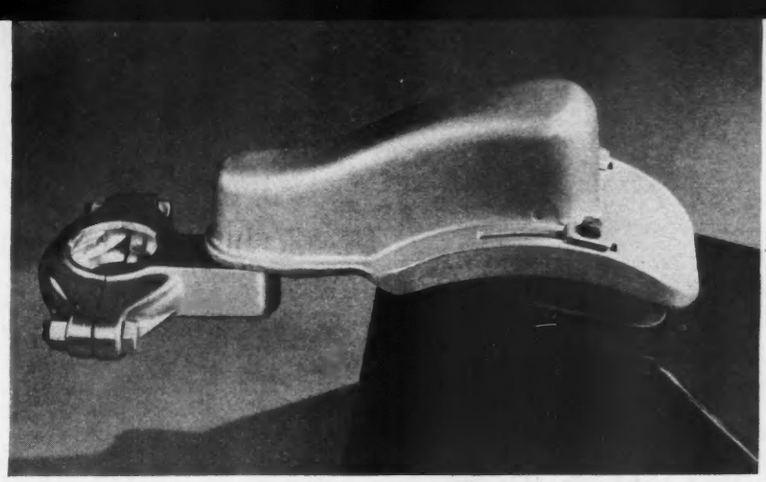


FALKS "Areaflood" weatherproof wide-range fitting for use with tungsten or mercury lamps

FALKS "Areaflood" throws the light exactly where wanted



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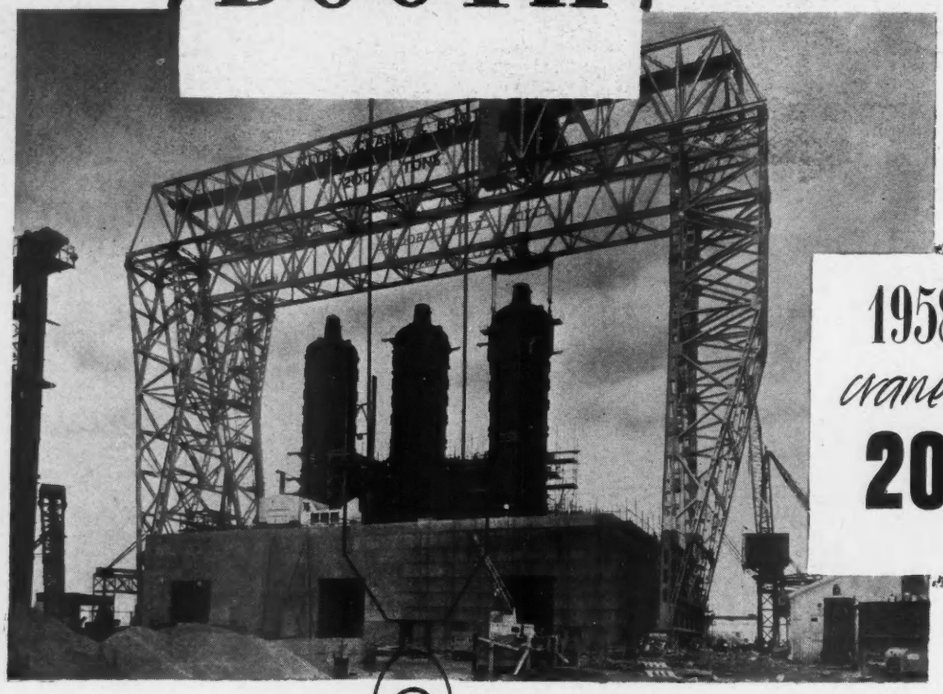

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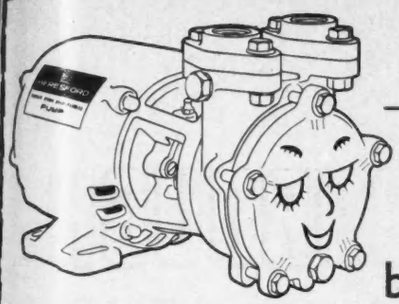

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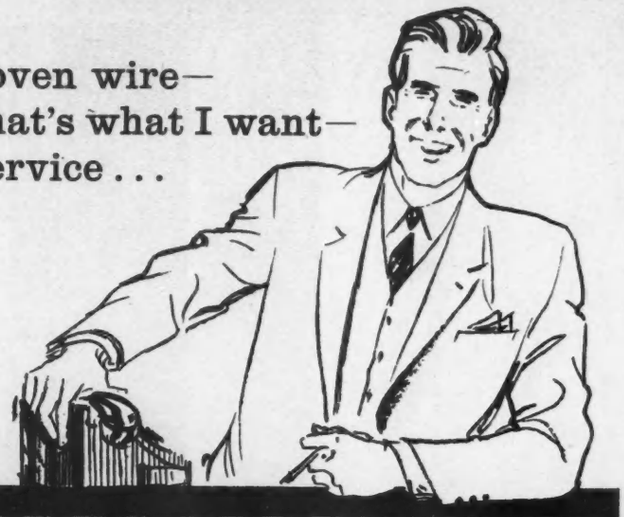

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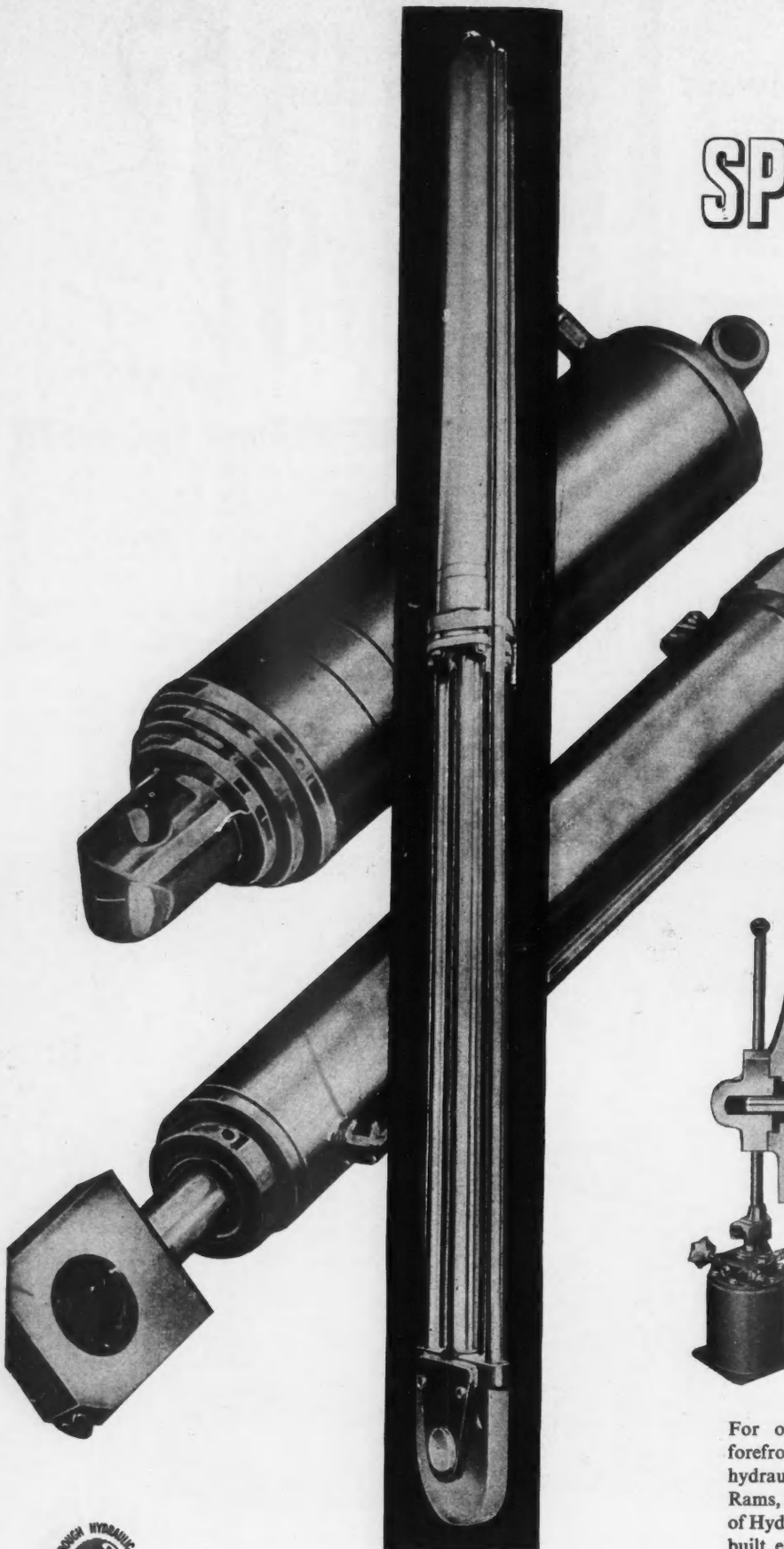

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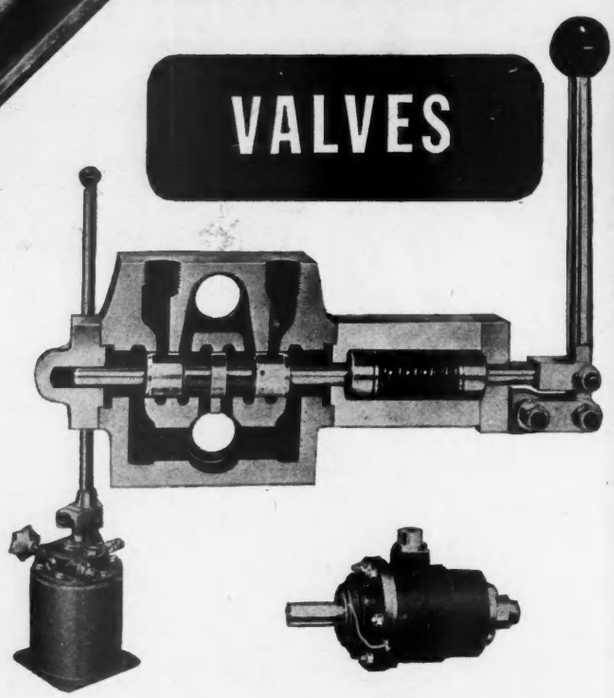

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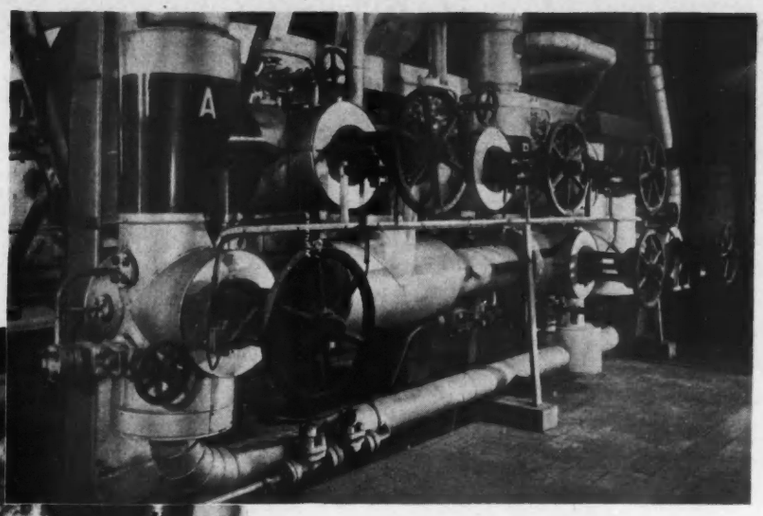
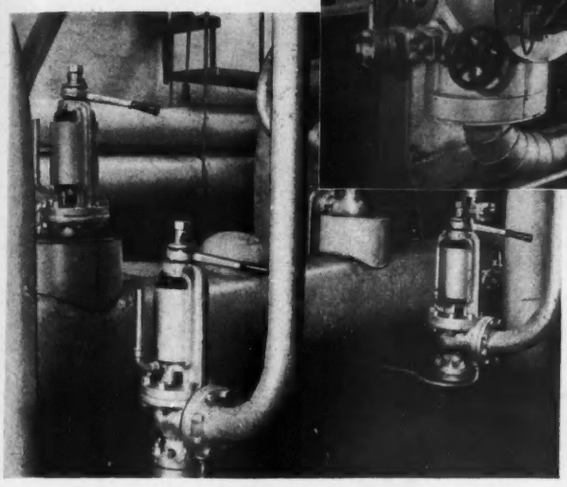


Hopkinson - Ferranti valves etc. at Aalborg Power Station.



Hopkinsons' "Hylif" Safety Valves at the Danish Soya Flour Factory, Copenhagen.

In addition to valves and boiler mountings installed in many important Danish industrial and public utility plants, Hopkinsons' equipment has been supplied to the following electricity generating stations—

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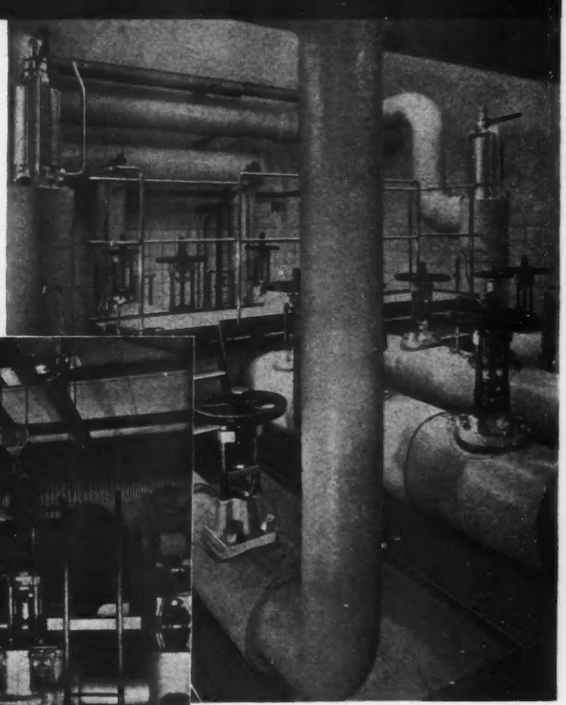
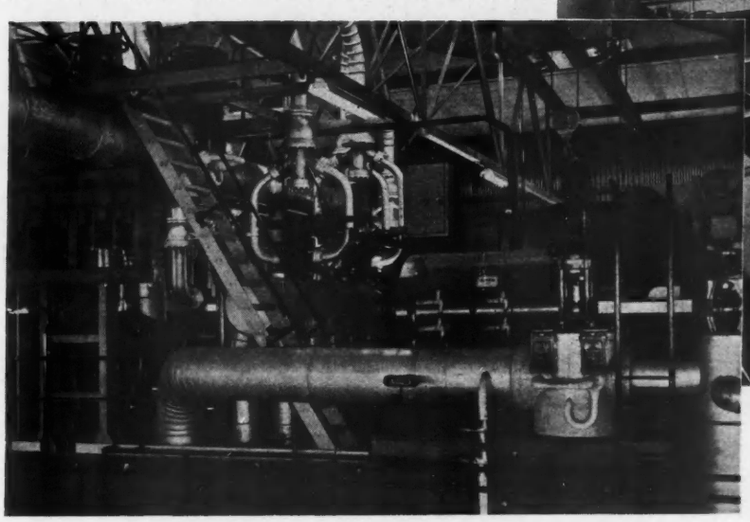


Hopkinsons' Torsion-bar Safety Valves, Hopkinson-Ferranti Valve and electrical controls at Masnedø Power Station.



Hopkinsons' parallel-slide valves and "Hylif" Safety valves at the House of Parliament, Copenhagen.

HV140

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Regent Ursa P is used for these engines because it maintains its consistently high quality and because it keeps its high level of flashpoint, a desirable feature for all dual fuel engines.

URSA P is one of a wide range of diesel engine lubricants supplied by the Regent Oil Company to meet the needs of modern industry.

REGENT **URSA P**

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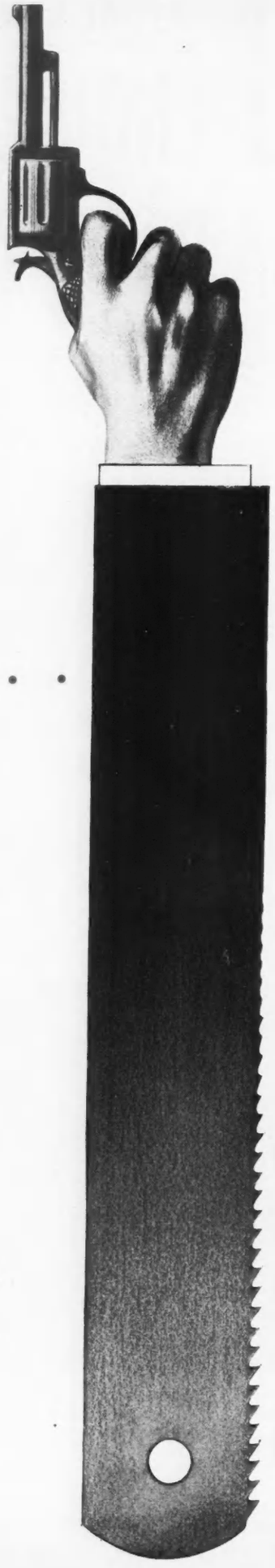

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PROGRESSIVE TEETH HACKSAW BLADES

With the pitch of teeth progressing from 29 to 18 per inch along its length, this blade takes advantage of the natural sawing action. The fine pitch lead-in reduces the effort required and minimises breakage, so often met when blades of incorrect pitch are being used. Supplied in SPEEDICUT High Speed Steel and DIE-HARD Alloy Steel in 10" and 12" sizes at the same price as normal blades.

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TUBE INVESTMENTS LTD.

DESIGN and DEVELOPMENT ENGINEERS

The Research and Development Organisation of Tube Investments Ltd. is being extended by the setting up of an Engineering Development Design Office at Bournemouth. This new Office will serve the interests of the various Divisions and Companies of T. I. in establishing the basic principles of production processes and in co-ordinating the development of new production plant.

This provides an unusual opportunity for engineers to initiate and to develop projects of economic importance to a Group with varied and expanding industrial interests.

There are openings at various levels of responsibility for

MECHANICAL ENGINEERS
ELECTRICAL ENGINEERS
CONTROL ENGINEERS

Applicants for these posts should preferably hold a First Class Degree in Engineering and should have some years of experience in industry or in research establishments.

Write stating age, qualifications and experience to the

DIRECTOR OF
RESEARCH AND ENGINEERING DEVELOPMENT,
TUBE INVESTMENTS LTD.,
The Adelphi,
John Adam Street,
London, W.C.2.

H 797

'Engineering' Appointments Section

PUBLIC APPOINTMENTS

THE ROYAL COLLEGE OF ADVANCED TECHNOLOGY, SALFORD

MECHANICAL ENGINEERING RESEARCH

Applications are invited from suitable persons for appointments in the Department of Mechanical Engineering to be responsible for the organization, design and care of equipment used for teaching and research, and for assisting the academic staff in carrying out research in mechanical engineering subjects.

Applicants should normally have a degree or an H.N.C. in Engineering or Physics and for the senior post should have had considerable experience in development work or scientific research. The salary for a junior appointment will be progressive within the ranges £815 rising to £960 p.a., or £960 rising to £1140 p.a., and for a senior post within the range £1140 rising to £1310 p.a.; in each case, the commencing point will depend upon experience and qualifications. Persons with experience in one of the following fields are required:—

Machine tool design and development.
Hydraulic or electro-mechanical control systems.
Machining or metal deformation processes.
Mechanical vibrations.

The vacancies offer excellent opportunities under good conditions to persons who wish to devote themselves full-time to research and development work in an expanding organization.

Certain of the posts are permanent and pensionable; one is temporary for two years, but the person appointed will be considered for a permanent appointment at the end of this period. Eighteen days annual leave is allowed.

Applications setting out full particulars relating to age, qualifications and experience and names of two persons to whom reference can be made, should be addressed to the REGISTRAR, ROYAL COLLEGE OF ADVANCED TECHNOLOGY, SALFORD 5, LANCS, by 12th JANUARY, 1962.

H 812

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY ST. JOHN STREET, LONDON, E.C.1

Immediate applications invited for the post of SENIOR LECTURER IN AUTOMATIC CONTROL in the Department of Production Technology and Control Engineering. Duties include teaching in Post-Graduate and Dip. Tech. courses, development of laboratories and supervision of research.

Personal research and consultancy encouraged.

Salary scale at present £1588 to £1801, but this is to be revised upwards from 1st January.

Forms and further particulars from the SECRETARY. H 818

PONTYPOOL AND DISTRICT HOSPITAL PONTYPOOL, MON. (126 BEDS)

Assistant Engineer required. The successful candidate will be directly responsible to the Superintendent Engineer and the post provides useful experience. Salary £655 × £25 (2) × £30 (3) to £795. Candidates should possess the Ordinary National Certificate or be studying for same. No residential accommodation available, but assistance given in finding accommodation in locality.—Apply stating age, experience and two referees to T. A. JONES, GROUP SECRETARY, 64, CARDIFF ROAD, NEWPORT, MON. H 827

UNIVERSITY OF ABERDEEN DEPARTMENT OF ENGINEERING

Applications are invited for LECTURESHIP in Engineering. Duties will include teaching and research in Applied Mechanics and one or more of the usual civil engineering subjects. Salary on scale £1050-£1850 with placing according to qualifications and experience. F.S.S.U., children's allowance and removal allowance.

Particulars from the SECRETARY, THE UNIVERSITY, ABERDEEN, with whom applications (8 copies) should be lodged not later than 31 JANUARY, 1962. H 813

MINISTRY OF TRANSPORT CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1st January of the year in which application is made (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential; knowledge of Highways Authorities' procedure desirable. National salary £936-£1258 according to age, rising to £1430. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting **S/64.** H 807

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW
(In affiliation with the University of Glasgow)

DEPARTMENT OF MECHANICAL CIVIL AND CHEMICAL ENGINEERING

Applications are invited for the post of

LECTURER IN CHEMICAL ENGINEERING

Candidates should have an Honours degree in Chemical Engineering and some industrial experience. In addition to teaching duties appointee will be expected to study for a higher degree. Salary on scale £1050 × £50 to £1400 × £75 to £1850 with superannuation and Family Allowance benefits.

Further particulars and forms of application from THE SECRETARY, GEORGE STREET, C.1. H 822

EXECUTIVE ENGINEERS POST OFFICE

Pensionable posts in London and provinces for mechanical, electrical and electronic engineers (male) at least 21 and normally under 35 on 1st September of the year in which they apply, to develop and design communications systems and postal services. Qualifications: normally degree, or Dip.Tech., in engineering or physics or, exceptionally, evidence of very high professional attainment may be accepted in lieu. Starting salary (Inner London) £762-£1318 according to age. Scale maximum £1573. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting **S/322.** H 805

UNIVERSITY OF SYDNEY ASSOCIATE PROFESSOR IN CONCRETE TECHNOLOGY

Applications are invited for the above-mentioned position in the Department of Civil Engineering. Candidates should have held a University teaching appointment and have had experience in a responsible position of both design and construction of concrete structures including reactor shields.

Salary will be £A3300 per annum, plus cost of living adjustments (at present £A47 p.a.) and will be subject to deductions under the State Superannuation Act.

Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH (BRANCH OFFICE), MARLBOROUGH HOUSE, PALL MALL, LONDON, S.W.1.

Applications close in Australia and London on 24th JANUARY, 1962. H 820,

MIDDLESEX COUNTY COUNCIL

EDUCATION COMMITTEE

ENFIELD TECHNICAL COLLEGE

QUEENSWAY, ENFIELD

MIDDLESEX

Principal: R. McCRAE, B.Sc.(Eng.), M.I.Mech.E.

Required for 1st May, 1962:—

HEAD OF THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

Candidates must be University Graduates in Civil or Mechanical Engineering and should be Corporate Members of one or both Institutions. They should have had wide teaching and industrial or research experience.

Salary Scale: Grade V—£2455 to £2660 p.a.

Application forms and further particulars of the post may be obtained on application to the CHIEF EDUCATION OFFICER (F1), MIDDLESEX COUNTY COUNCIL, 10 GREAT GEORGE STREET, WESTMINSTER, S.W.1, to whom completed applications should be returned by 12th JANUARY, 1962.

C. E. GURR, M.Sc., Ph.D.
Chief Education Officer. H 815

INSTRUCTORS IN DRAWING

Two vacancies exist at the Army Apprentices School, Chepstow, Mon., for Instructors in Drawing. Applicants should possess H.N.C. in Building or Mech. Engineering (or similar qualn.). Preference given to applicants who have served an apprenticeship (or equiv.), which gave good comprehensive training. This should have been followed by at least 3 years practical experience as an instructor or supervisor of labour. Service as a Military Clerk of Works would be acceptable. One of the successful applicants will be required to specialise in the teaching of Drawing for Building Construction and the other will be concerned primarily with instruction in Mechanical Drawing. The appointments are classed as Instructor Grade III (Drawing). Salary will be within the range £993 (at age 30) to £1071.—Apply in writing to COMMANDANT, ARMY APPRENTICES SCHOOL, CHEPSTOW, MON., or to any Employment Exchange, quoting CHEPSTOW O/N 256 by 13 January, 1962. H 825

MANCHESTER REGIONAL HOSPITAL BOARD

BUILDING AND ENGINEERING CONTRACTS

The Board are prepared to receive from *main* building contractors and *main* engineering contractors not already on the Board's approved List of Contractors, applications for inclusion in such list.

Interested Contractors should write to the SECRETARY OF THE BOARD, CHEETWOOD ROAD, MANCHESTER 8, for form of application and further details not later than 7 days from date of insertion. H 829

BELFAST HARBOUR COMMISSIONERS

The Belfast Harbour Commissioners invite applications for an ASSISTANT ENGINEER (age about 25 years).

Applicants should preferably have a University degree in Civil Engineering and/or be qualified to hold corporate membership of the Institution of Civil Engineers.

Salary will be in accordance with qualifications and experience.

The successful applicant, who will be appointed for a probationary period of six months, may, if satisfactory, be considered for appointment to the Board's permanent staff.

Applications, stating age, qualifications, etc., must be addressed to the undersigned, endorsed " Assistant Engineer," and delivered not later than 15th January, 1962.

The person appointed will be required to reside within or in the vicinity of the City of Belfast.

Canvassing in any form, either direct or indirect, will be a disqualification.

F. W. P. HAMPTON,
General Manager and Secretary.
HARBOUR OFFICE,
BELFAST, 1.
11th DECEMBER, 1961. H 828

APPOINTMENTS OPEN

GRADUATE ENGINEER

GRADUATE ENGINEER (Civil, Mechanical or Structural) aged about 25, required by Westminster Head Office of major oil company as Assistant to Project Engineer engaged in the design and administrative supervision of new developments connected with extensive expansion programme. Applicants need only have limited engineering experience and not necessarily in the oil industry. Good starting salary and many employee benefits.—Applications, quoting GE7022, with details of age and experience to BOX H 810, Offices of ENGINEERING.

BRITISH ENGINE BOILER & ELECTRICAL INSURANCE CO. LTD.

LONGRIDGE HOUSE, MANCHESTER, 4

Surveyors of Boiler and Engine plant required. Permanent positions carrying progressive salary scale £825 to £1225 and non-contributory pension. Candidates, age not exceeding 32 years, having steam boiler and engine experience and possessing at least 1st Class M.O.T. Certificate are invited to apply stating age, qualifications and experience. H 814

ENGINEER REQUIRED BY COLONIAL DEVELOPMENT CORPORATION AT ITS HEAD OFFICE IN LONDON

Applicants should be between 28 and 40 years of age, possess a good engineering degree and be members of one of the professional Engineering Institutions, preferably IEE or IMechE. Practical experience in development or consulting engineering is essential.

The successful candidate will be a member of a team responsible for the investigation of diverse engineering problems arising from the Corporation's operations; he will be required to undertake frequent visits overseas. The post is pensionable.

Applications giving full details of qualifications and experience with an indication of the salary required should be sent to the PERSONNEL OFFICER, 33 HILL STREET, LONDON, W.1, quoting SERIAL NO. 649. H 826

PART TIME AGENT

PART TIME AGENT required by North of England Ironfoundry seeking to expand present field of activities.—Reply stating experience, type of connections and area covered to BOX H 817, Offices of ENGINEERING.

BEECHAM GROUP LIMITED

have a vacancy for an

ENGINEER

required to take charge of maintenance of Head Office premises covering an extensive area.

Essentials are a recognised qualification in civil engineering; mechanical and electrical experience, with a sound knowledge of building works, and heating and ventilation systems.

The appointment will carry considerable responsibility, and will require personality to control staff and have dealings with top management executives.

The salary is attractive and there are Profit Sharing and Non-Contributory Life Assurance and Pension Schemes.

Applications in writing, giving full details of age, education, experience and salary required, and quoting ref. E154 to ESTABLISHMENTS OFFICER, BEECHAM GROUP, LTD., BEECHAM HOUSE, GREAT WEST ROAD, BRENTFORD, MIDDLESEX. H 819

CIVIL ENGINEER REQUIRED BY THE CAMEROONS DEVELOPMENT CORPORATION

The successful candidate will be A.M.I.C.E. or A.M.I.Mun.E. or have exemption from Parts A and B of the " Civils," with general engineering experience on design and programming including roads, drainage, water supply and housing and industrial or factory design including plant. Age range 30-40 years. Commencing salary about £1700 per annum inclusive, plus participation in the bonus scheme. Free passages. Free furnished accommodation and a reasonable amount of free light and fuel. Free medical attention in the territory. Children's allowances are payable up to a maximum of two, at the rate of £75 each p.a. Outfit allowance £80. Tours of 18-24 months with good leave on full pay.

Applicants should send personal particulars and experience to the PERSONNEL OFFICER, COLONIAL DEVELOPMENT CORPORATION, 33 HILL STREET, LONDON, W.1, quoting Serial NO. 647. H 811

MACHINE SHOP MANAGER

MACHINE SHOP MANAGER (35/45) required for department containing all types of British and Foreign machine tools and including a fitting section. The machine shop employing about 100 operators is not engaged in production machining but forms part of a precision forging works in the West Riding. Applicants will be expected to have considerable experience in management as well as possessing high technical ability. Staff pension scheme in operation. In reply state full particulars of education, previous experience and salary range expected, marking envelope " For the attention of the Works Manager." BOX H 790, Offices of ENGINEERING.

STRUCTURAL ENGINEERING

Edinburgh architects, expanding their engineering side, urgently require ENGINEERING ASSISTANT. Experience in reinforced concrete is required but applicants should be capable of dealing with all building materials, including brick and timber.

This is a job of special interest to anyone wishing to work in close collaboration with all members of the professional design team and wishing to study the whole building process from initiation to handing over.

Personal and congenial working conditions.

Apply BOX H 808, Offices of ENGINEERING.

COMPANY MEETING

SAMUEL OSBORN & CO., LIMITED

Sales and Profits Reach New Peaks. Mr. Frank A. Hurst's Statement

The 56th annual general meeting of Samuel Osborn & Co., Limited, was held on December 11 at Sheffield, Mr. Frank A. Hurst (chairman and managing director) presiding.

The following is an extract from his circulated statement:

During the year ended 31st July, 1961, the majority of the companies of the Group worked to capacity, consistent with the labour available, and, consequently, we have surpassed the sales figure of the previous year which I then reported as a record for us. We have now, therefore, a still higher target to beat.

Not only have we beaten our previous sales record by a substantial margin but, I am also pleased to be able to say, we have record profits for the year of £2,025,858 before tax and £976,900 after tax. Tax in the United Kingdom takes £972,001 and overseas £65,773; thus these first charges on profits reduce the total by approximately 51 per cent. From these figures the exceedingly heavy burden we have to carry will be appreciated.

I am still disappointed that those in authority continue to criticize British management and at the same time fail to do anything to curb the extravagant national expenditure, which could do much to help us meet increasing world competition by a reduction in taxation.

EXPORT TRADE

During the year under review our direct exports have improved but we continue to strive for further achievement. This must, however, be considered together with the fact that a large percentage of our products sold in the home market goes towards the making of other British products which are ultimately exported.

The purchasing side of our business has made a considerable contribution towards our success in that careful contracting has been exercised—a very important feature when purchases are so heavy.

THE EUROPEAN COMMON MARKET

I am sure that I am expected to say something about the European Common Market and I regret my inability at this stage to be categorical upon the matter. I have been surprised at the ready way many have expressed themselves as being positively for or against, because none of us really has grounds upon which we can decide, and when we do so it must be not from any selfish point of view—connected with one industry—but in the over-all national interest. All I can say is that I hope our negotiators will competently be able to appraise the advantages and disadvantages so as to enable them to make such arrangements as will be compatible with the interests of the United Kingdom and the British Commonwealth.

I am amongst the foren ost in my desire that the Commonwealth should be protected in any arrangements which we may reach with the countries of the Common Market, but I feel I must say to some of the Commonwealth Governments that they must not look on the Commonwealth as a " one-way street." If they wish to continue exporting their goods to us on Imperial Preference terms, they should not impose harsh restrictions on our attempts to export goods to them, whether by restrictions of imports, the imposition of high duties or the narrowing of Preference tariff margins in favour of outside competitors.

On previous occasions I have mentioned the question of dumping and have advocated quick measures for the implementation of the provisions of the Customs Duties (Dumping and Subsidies) Act, 1957, when the necessity occurs. I make no excuse whatsoever for returning to this matter which I have been hammering for some years. Our Government is ready to criticize the efforts of manufacturers but, when faced with this simple problem of protection against dumping, continues to turn a deaf ear and professes to know better than those it criticizes. At the same time it deplores the gap in our balance of payments which is widened by dumping. Other Governments are apparently more ready to aid their manufacturers; an example being that in the Canadian publication, *The Financial Post* of 7th October the first paragraph on the editorial page reads " The Justice Department stands ready to advise Canadian companies whether their plans to join forces to meet foreign competition in the domestic market would contravene the Combines Act "—and goes on to hint at the desire to cut imports.

THE OUTLOOK

To forecast the future is a most difficult and uncertain matter which is made still more complicated by complexity of world politics, but I can report that we continue to be very active in those departments which have been busy throughout the financial year under review. At the same time I have to say that the volume of orders received is slightly less than a few months ago. However, it is too early to tell what the future has in store, but we do know that we have remained very busy at a time when it would seem that some of our competitors had suffered a certain amount of recession. During the period covered by the Accounts we have added new plant and made a number of extensions so we hope that by these means and by the fortunate position we occupy due to the diversification of our manufactures our prosperity will be maintained.

I conclude by expressing my thanks to everyone in the Osborn organization from Directors to juniors, and to our subsidiaries and agents alike; all have helped by giving unfailing support. I have had co-operation in every direction and our success is due largely to a spirit of happy working together, mutual respect and loyalty.

The report and accounts were adopted.

H 777

WHO PUTS THE SPEED INTO WELDING?

Obviously the welder himself. But he must have electrodes worthy of his skill. AEI meets this need for speed more certainly than ever before with its new GAZELLE Electrode. These mild-steel electrodes are expressly made with the welder in mind. Their ease and speed of use and good de-slagging properties should revolutionize mild steel fabrication and welding work.

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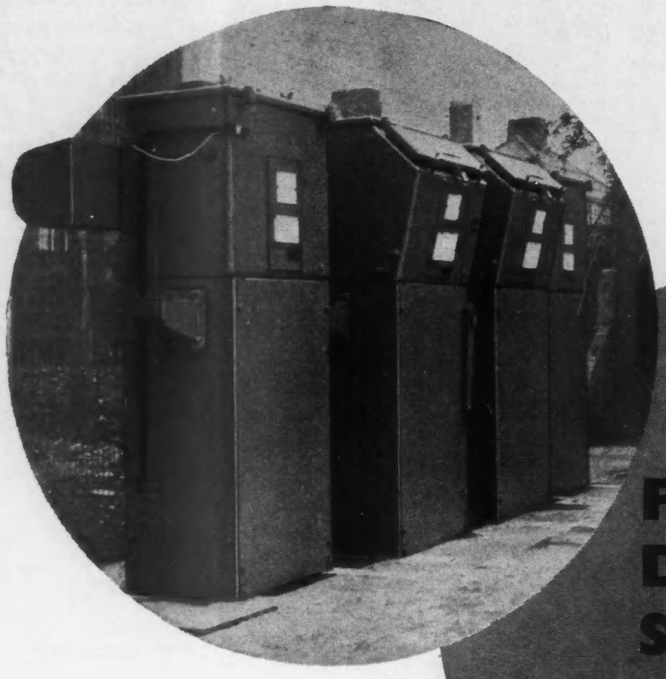

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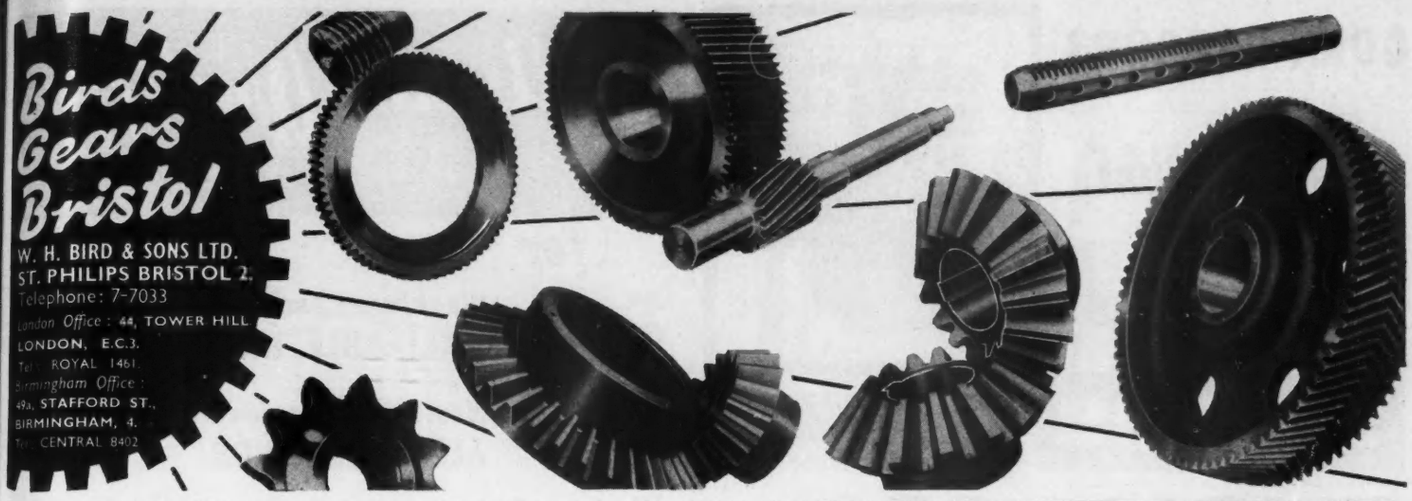

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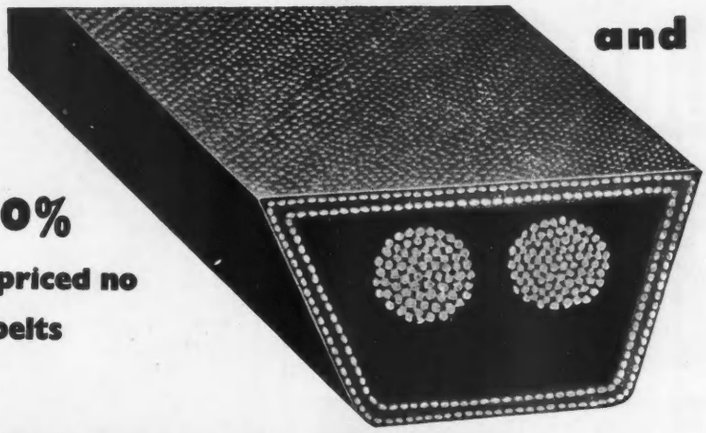

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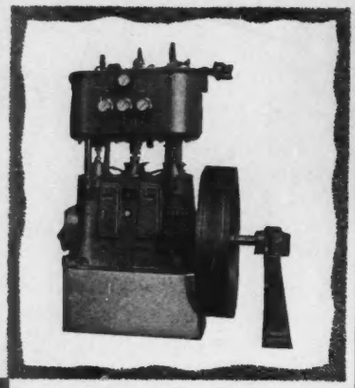

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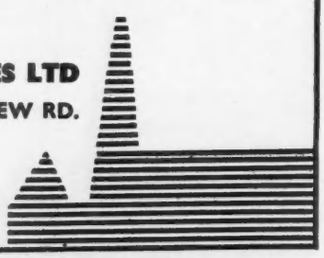

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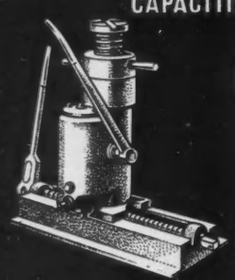

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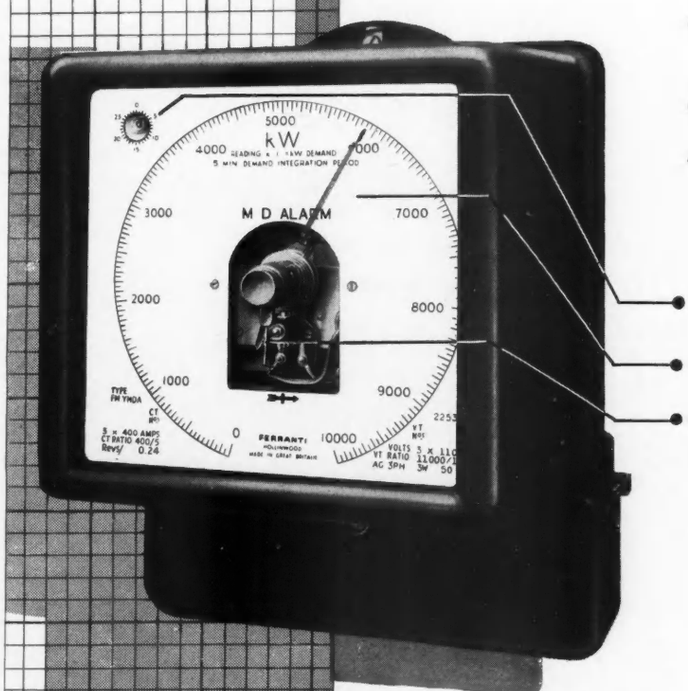

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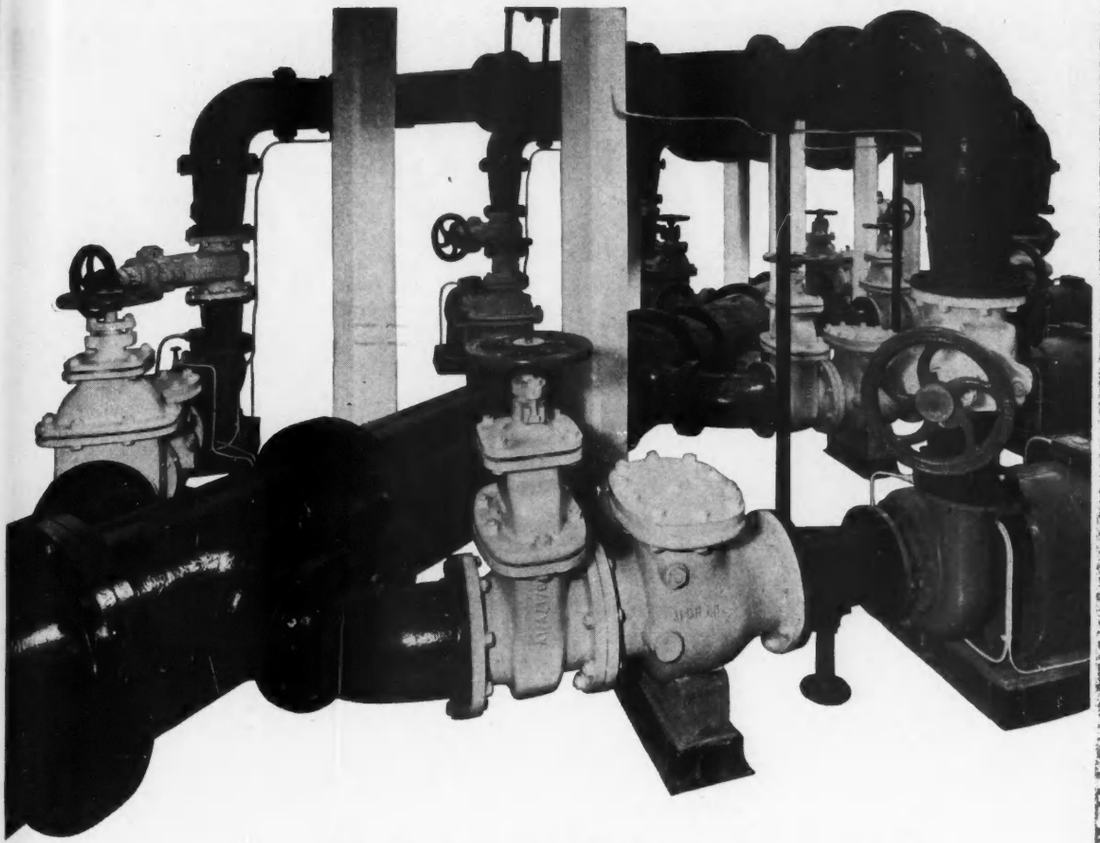
GC.20

ICI
GENERAL CHEMICALS DIVISION



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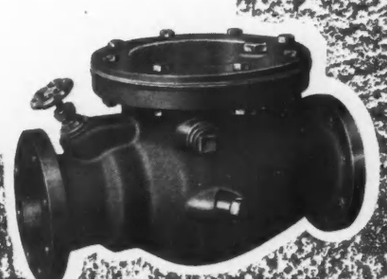
for Pumping Stations

Pumping Stations in many branches of industry are equipped with Glenfield Valves to give the necessary efficient and reliable control of flow.

Illustrated at site are hand-operated sluice valves and orthodox single swing-disk check valves ; and in cut-out form, examples of hydraulically-operated automatic self-closing sluice valves, foot valves, and tilting-disk and Recoil styles of check valves.



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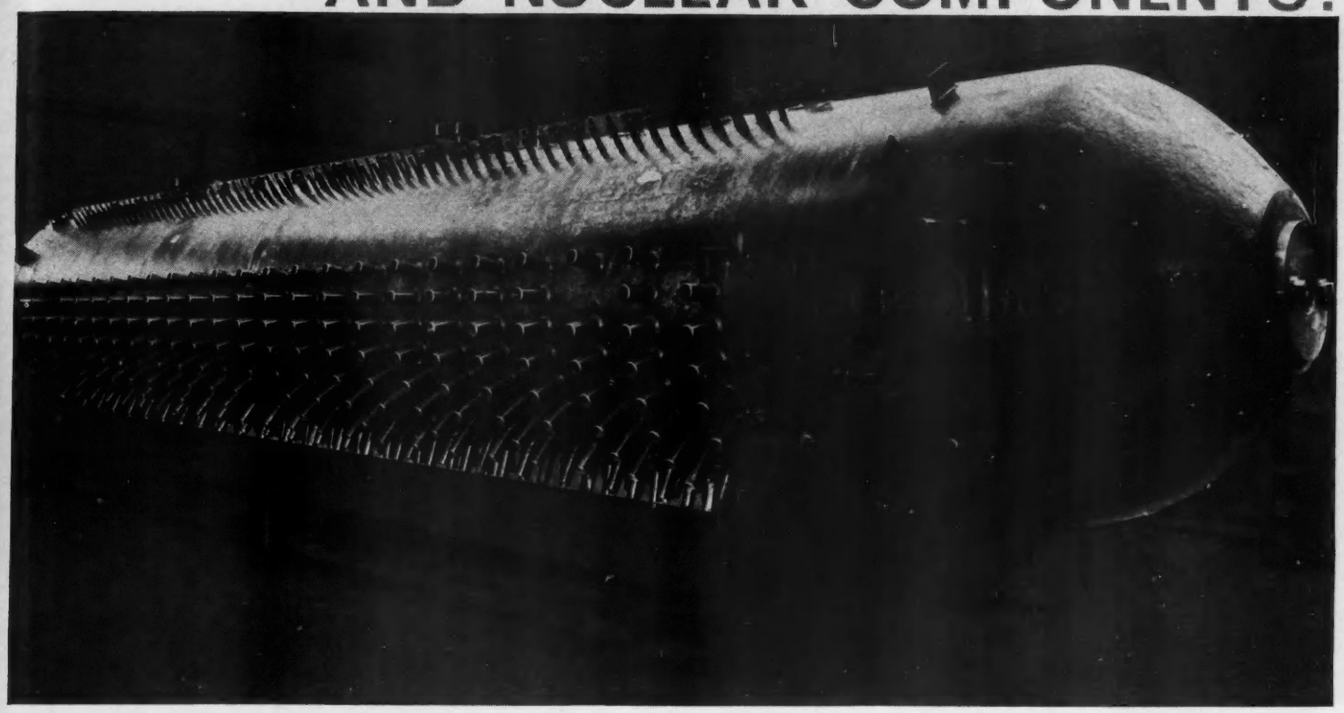
WHY »REISHOLZ« REACTOR VESSELS TUBES AND NUCLEAR COMPONENTS?



This 60 ton high-pressure vessel is an example of the REISHOLZ *technique of assembling exceptionally large units from several sections without longitudinal welds. Below: Exploded view of reactor vessel assembled in this way.*

BECAUSE

REISHOLZ have long and specialized experience in the manufacture of high-pressure and high-temperature components

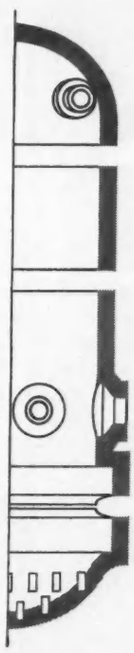
Because REISHOLZ are highly competitive, for instance by making their own high-duty steels

Because REISHOLZ hammer forge can handle 120 ton ingots for exceptionally large solid or hollow units

Because REISHOLZ operate a unique horizontal press producing very large seamless vessels and tubes up to 35 in. i.d. and 9 in. wall thickness

Because REISHOLZ special welding facilities (including build-up welding) enable them to assemble up to 60 ft. long pressure vessels without longitudinal welds, for any desired pressure

Because REISHOLZ research into the suitability of various steels for nuclear engineering have given them a wealth of know-how in this specialized field



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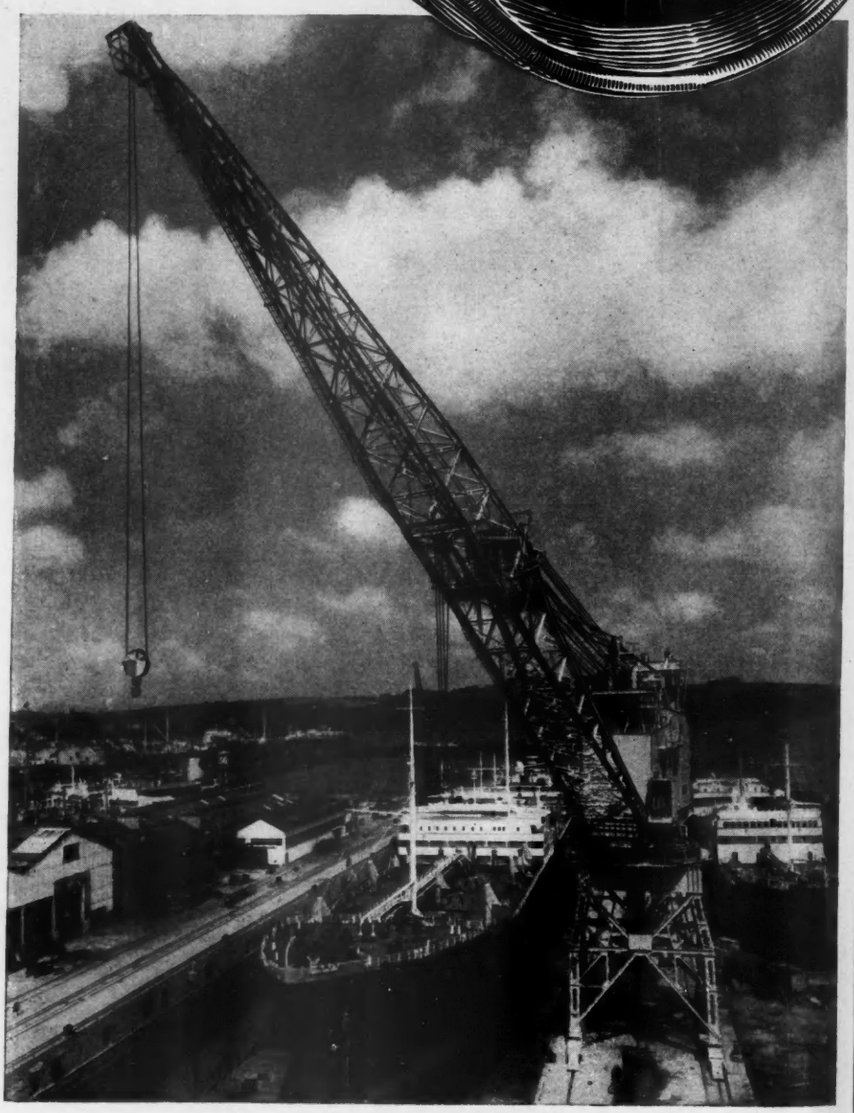

Falmouth Landmark

Visible far out at sea, this Falmouth giant is also a landmark in Stothert & Pitt's 140 years of crane building. Half as high again as Nelson's column, it is the largest balanced rope level-luffing crane ever built by the company, and one of the largest in the country.* Further proof, in fact, of S & P leadership in crane design and manufacture.

* Performance matches size—the crane lifts 61 tons at 105 feet and at 175 feet can lift 12 tons. Ward Leonard hoist drive ensures precision control on both main and auxiliary hooks.

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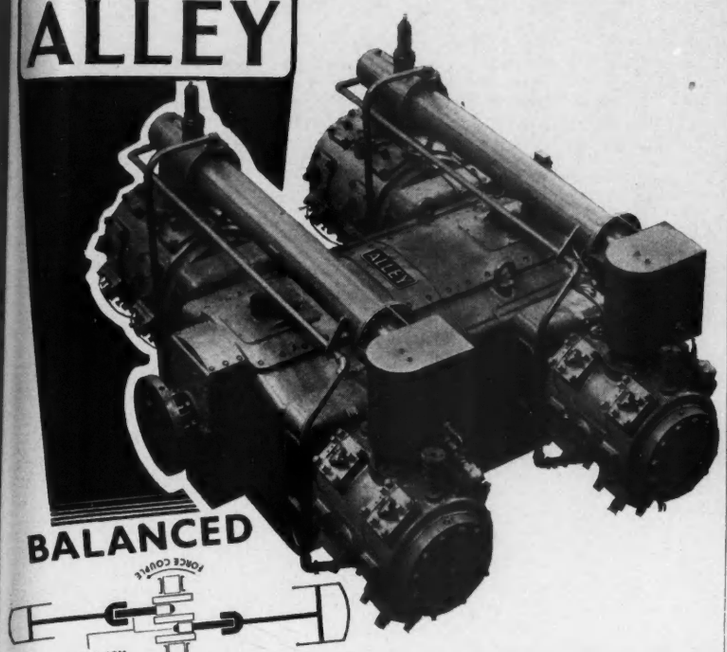

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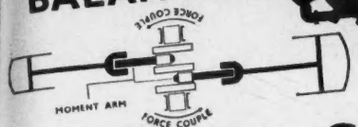

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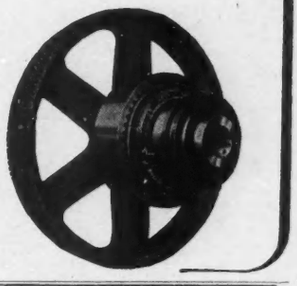

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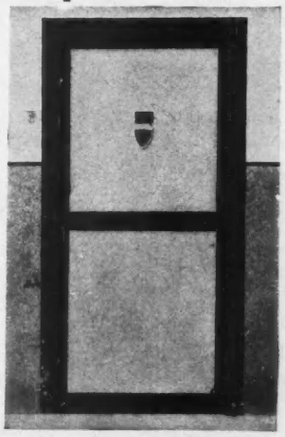

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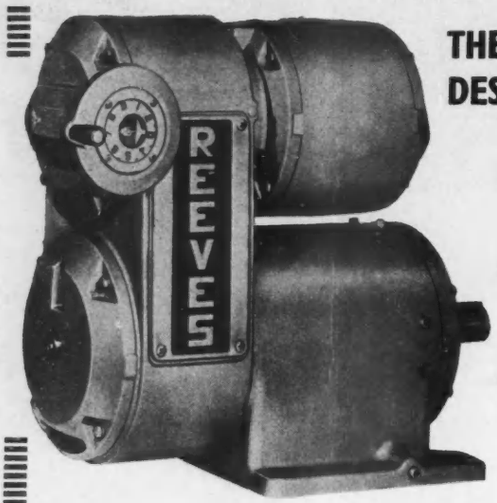

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The REEVES Vari-Speed Motodrives are complete variable speed power packages designed to give ultimate performance and operating efficiency to applications in every industry. Right Angle Reducer units are also offered with the same rugged construction and simplicity of operation for year-round dependable service.

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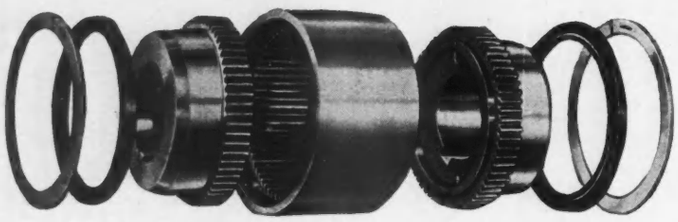
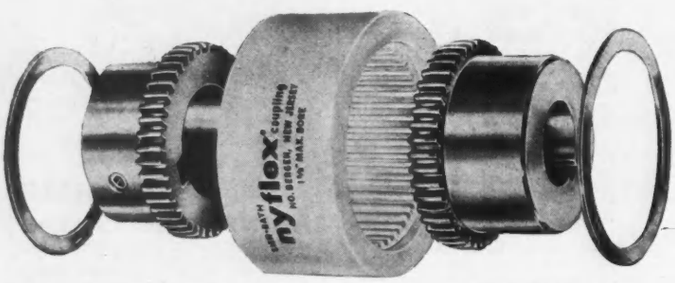


Standard Coupling—7 parts only. 3/5 usual size, ⅓ usual weight of flange coupling. More horsepower with less weight and size. Assembled, uncoupled in seconds. No wrenches or special tools required. Safe and silent as smooth shafting. Absorbs misalignment and end-float.



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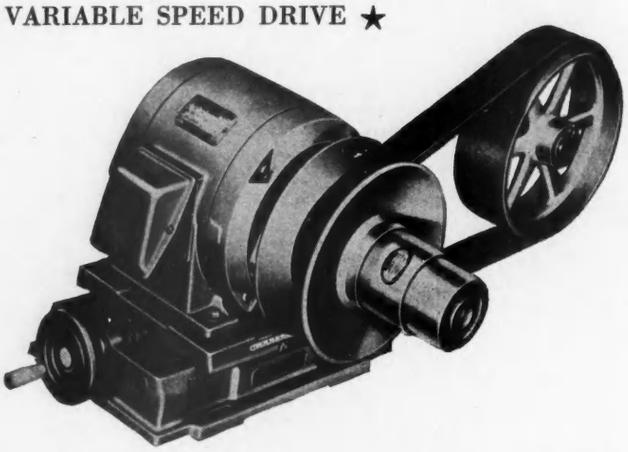

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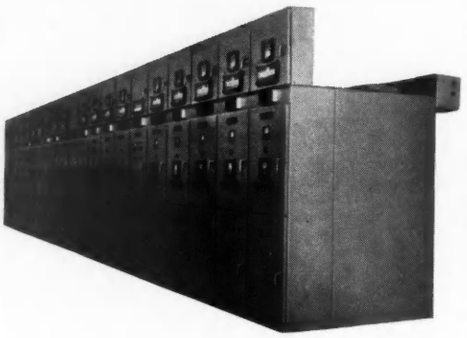

Overall view of HSA Air-break switchgear

For further details get in touch with the Switchgear Division, Trafford Park, Manchester 17, or your local AEI office.

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